NEW INTEL CHIP NUKES THE WORK-STATION MARKET/25

NONVOLATILE TECHNOLOGY TAKES ON A STRATEGIC ROLE/80

A VNU BUSINESS PUBLICATION IN U.S. $6.00 MARCH 1989

Electronics®

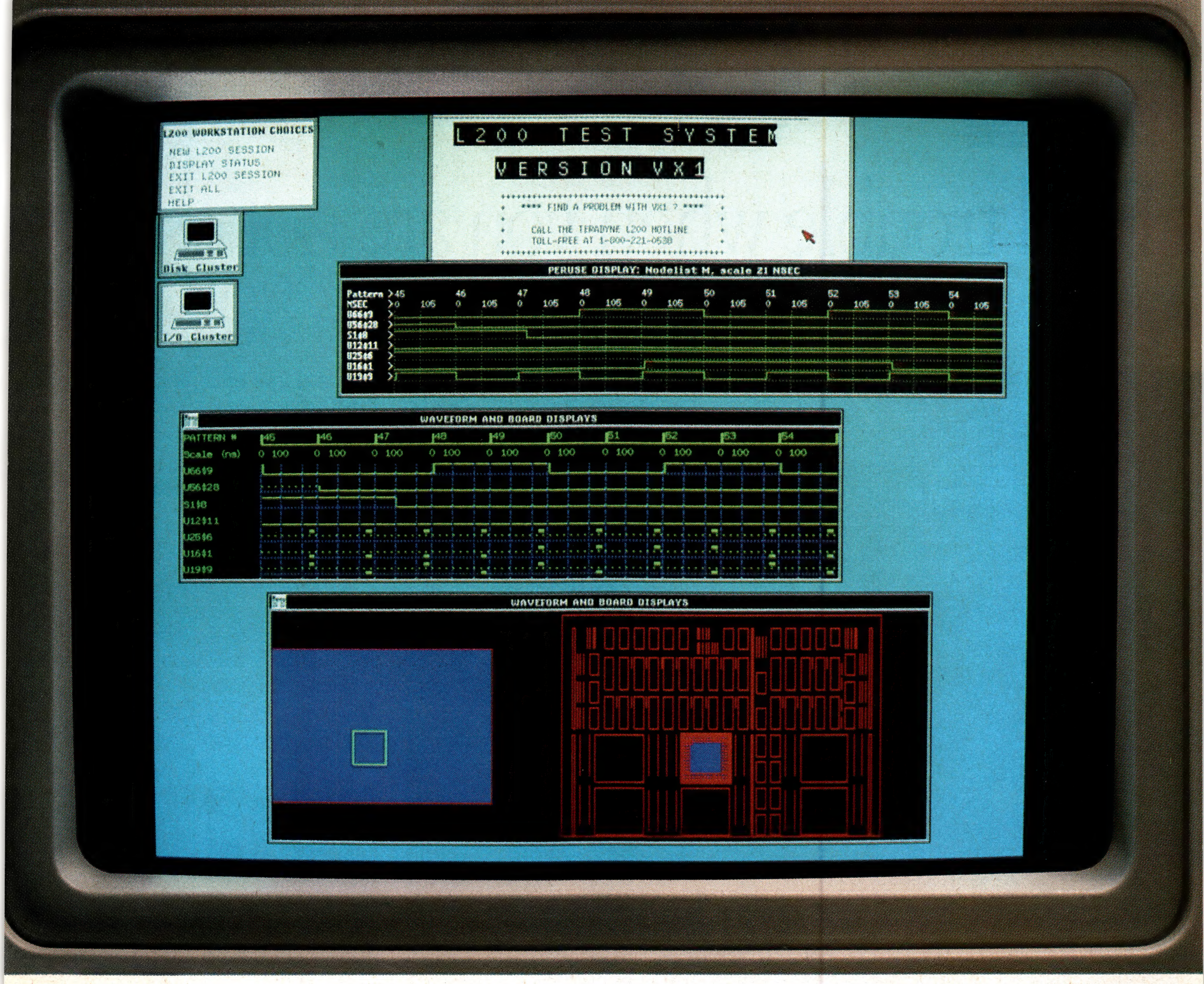
28 MAR 1989

HDTV: CAN THE U.S. GET ITS ACT TOGETHER?

NEXT-GENERATION TELEVISION

PAGE 70

FACTIONS IN INDUSTRY
PULL MANY DIFFERENT WAYS
EVEN AS AGREEMENT GROWS ON THE
CRITICAL IMPORTANCE OF HDTV TECHNOLOGY



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Circle 119

Electronics

International edition

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BENNY AND THE NETS

By the time America turns on HDTV, will we find anything more than a new format for old jokes?

Some weeks ago, when we were talking about putting a cover on this issue based on our high-definition TV package (p. 70), I had an idea for a visual that—and this is almost certainly a good thing—I discarded immediately prior to initial verbalization. It has stayed with me, however, and now I just have to tell somebody. If you really want to get across what HDTV is going to mean, you see, here's what you do: you merely take a TV screen shot of the consummate British middlebrow comic, Benny Hill, holding his hands out in front of him about 24 inches apart. His eyes bug out. His tongue tries to escape out of one side of his mouth, then the other. He clenches his teeth to get control of it, then begins to repeat, ad infinitum: "It's big! It's big! It's . . . BIG!"

How big—apologies to Ed McMahon—is it? William Schreiber, who heads the MIT Media Lab's Advanced Television Research Program, believes public acceptance could make HDTV the "largest consumer of [both] memory chips and microprocessors." That means bigger than the computer industry. That means bigger than industrial electronics. What's more, the ultimate effect of the worldwide market for HDTV as a technology driver for everything from advanced semiconductors to high-resolution displays can only be projected at this point in terms of incalculable significance. Some visionaries see an inevitable merger of the home-entertainment center with the home computer, creating the 21st century equivalent of the home altar.

What will be a massive ripple effect is already in motion. Read how North American Philips is using an enhanced multiplexed analog-component technology scheme to "stitch together" an NTSC-sized picture with image-widening side panels (p. 78). Read why Zenith believes its process for directly printing color phosphors onto a faceplate will carry cathode-ray-tube technology well into the HDTV revolution no matter what flat-panel developments ensue (p. 79).

Despite all these encouraging signs, we are handing you plenty of downside in the picture. The U. S. has advanced to nowhere near adopting an HDTV standard, and isn't likely to advance in the near future. There are not even rumors of any kind of coherent policy among the industry factions who stand to lose the most—or everything—from lack of one. It's particularly discouraging because no matter who builds the new TV sets we will all eventually buy, or where they are assembled, until the U. S. gets its act together nothing is going to move very far or very fast.

And notice how, at a time when TV technology is approaching a major threshold, the combined product of the U. S. broadcast networks is playing to an increasingly indifferent audience—indifferent to the point of serious commercial impact. One hopes HDTV is not born into a world that couldn't care less. Personally, I can't wait to see Benny Hill reruns on that big screen. **ROBIN NELSON**

March 1989 Volume 62, Number 3

Electronics (ISSN 0883-4989). Published monthly by VNU Business Publications Inc. Publication office: Ten Holland Drive, Hasbrouck Heights, N. J. 07604; second class postage paid at Hackensack, N. J. 07602 and additional mailing offices.

Executive, editorial, circulation, and advertising addresses: Electronics, Ten Holland Drive, Hasbrouck Heights, N. J. 07604. Telephone (201) 393-6000. Facsimile (201) 393-6388. TWX 710-990-5071 (HAYDENPUB HBHT). Cable Haydenpubs.

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For subscriber change of address and subscription inquiries, call 215-630-4277.

POSTMASTER: Please send change of address to ELECTRONICS, P.O. Box 1092, Southeastern, Pa. 19398.

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The Series 1000 "desktop supercomputer" powers Apollo's recovery

The new family of analyzers from Rohde & Schwarz reaches the technological limits in the field of spectrum analysis. The universal RF Analyzer FSA, the Spectrum & Network Analyzer FSAS, the Communications & Spectrum Analyzer FSAC and the 5-GHz Analyzer FSB all provide technical performance, operating convenience and system capability which were previously unattainable. More information on the new spectrum analyzers can be obtained directly from Rohde & Schwarz Sales GmbH RSV-Z, Mühldorfstr. 15, D-8000 Munich 80, West Germany, Telephone (089) 403073, Telefax (089) 404764, Telex 524960.

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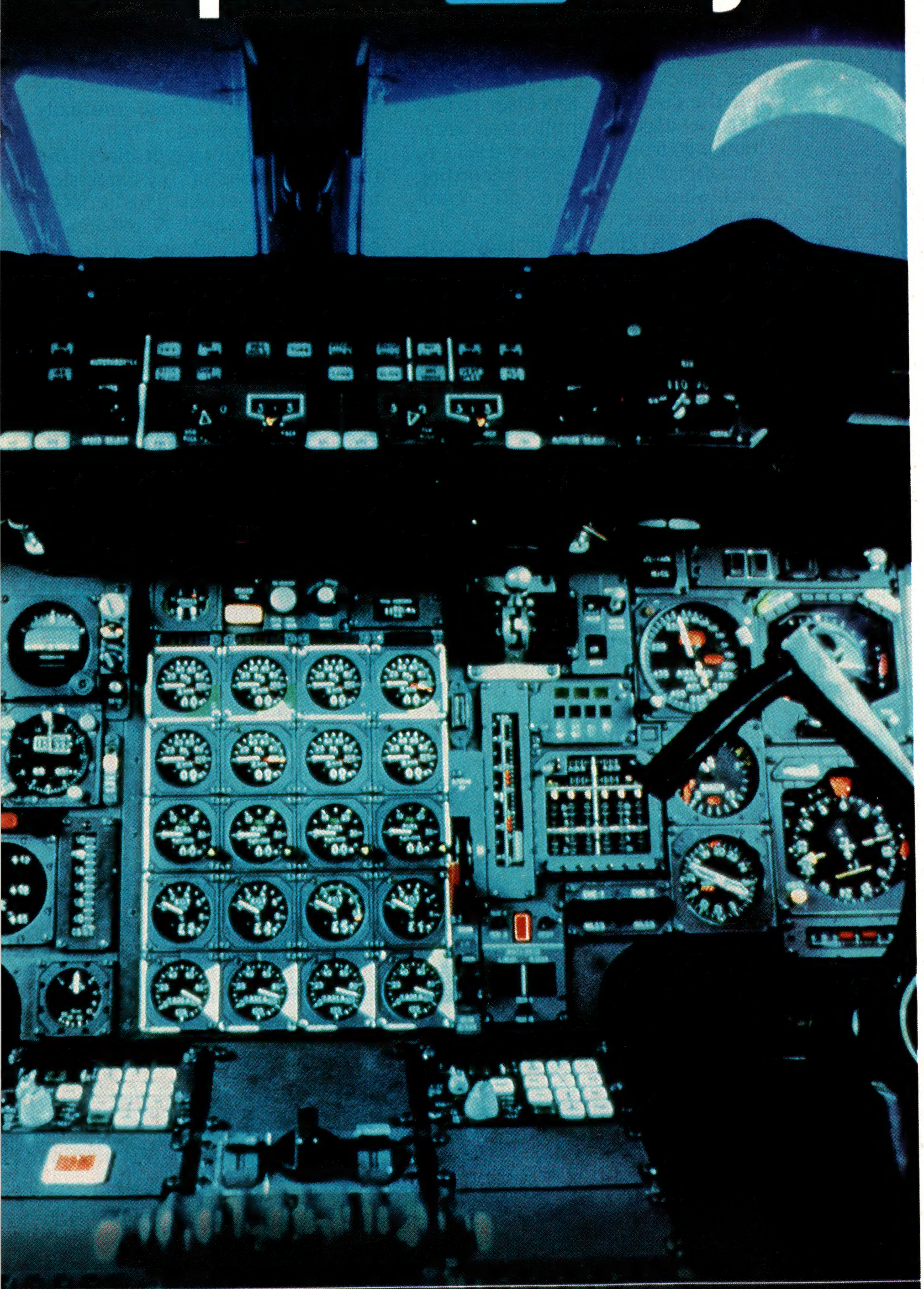

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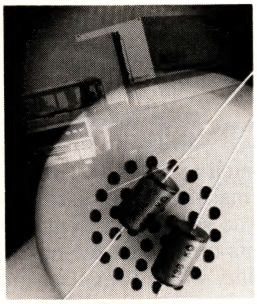
higher immunity to drying out, thus extending lifetimes to satisfy tough PTT and industrial applications. The capacitors slash the area needed on PCBs by around 40 percent and can function for up to 15 years at a temperature of 40 °C, so saving on maintenance costs.

A flame-retardant plastic is moulded around the capacitor case to minimize drying out, up to now the biggest disadvantage of non-solid electrolytics and a severe limitation on lifetime. The moulding also gives extra protection against accidental short-circuits.

The axially-leaded 138-series has a capacitance range from 0.22 μF to 220 μF over a rated voltage range of 6.3 V to 100 V. The operating temperature is −55 °C to +105 °C. The capacitors are supplied on bandoliers - in boxes or on reels.



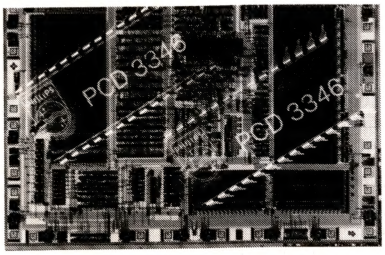
The 138-series non-solid electrolytics are more compact and offer longer life in demanding applications.

CIRCLE 802

CMOS microcontroller has 256-byte on-chip EEPROM

The CMOS PCD3346 is the first telecom microcontroller to incorporate an on-chip EEPROM that can be read, written to, and erased with a supply voltage as low as 2.5 V. The IC is particularly attractive for the increasing number of countries which don't allow batteries to be incorporated in equipment connected directly to telephone lines.

The 8-bit microcontroller has 256 byte of EEPROM which can store as many as 20 repertory numbers without needing battery backup. It extends the company's extensive telecom-oriented microcontroller family. The memory can hold sophisticated programs including pulse and DTMF dialling, last-number redial, extended redial, direct dial for emergency calls, dialled number display, and tariff metering.



The PCD3346 is the first telecomm microcontroller with on-chip EEPROM operating from just 2.5 V.

Based on the 8048 instruction set, the microcontroller has more than 80 instructions. There are two 8-bit programmable timers, and a power-on circuit. This circuit monitors the supply voltage, and resets the microcontroller if the voltage falls below 1.5 V. An on-chip interface for the industry-standard serial I^{2}C-bus can connect the microcontroller to a host of peripheral ICs including DTMF generators, LCD drivers, external RAM, and clock calendars.

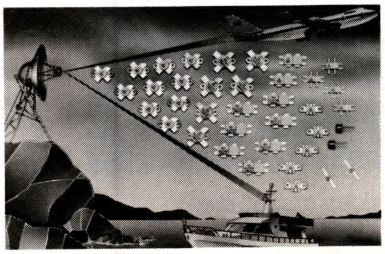
The PCD3346 operates from a supply voltage which may vary between 2.5 V and 6 V. Power consumption, already low thanks to the CMOS process, is further reduced by IDLE and STOP modes which reduce current consumption to 0.4 mA and 2.5 μA respectively.

The IC is available in a 28-lead plastic DIL or SO package.

CIRCLE 803

RF power MOSFETS offer low noise, higher power gain and easier power control

A new family of RF power MOSFETs provides several advantages over bipolar transmitting transistors for HF, VHF and UHF transmitters. The BLF series from Philips Components has output power ranging from 2.0 W to 300 W, typically 7 dB less noise in duplex mode operation than bipolar transistors, up to 4 dB higher power gain, and easier power control. They are also more reliable than bipolars, offering better thermal stability, higher tolerance to load mismatch and less tendency to parasitic oscillation.



New power MOSFETs step up performance and reliabilty of RF transmitters.

Initial devices in the BLF range are aimed at HF and VHF applications. New transistors will be added for UHF applications, and will include such features as wider bandwidth and higher gain. The HF/VHF devices are ideal for such applications as civil and military transmitters, FM broadcast transmitters, or drivers and output stages of TV transmitters.

The BLF MOSFETs come in SOT, TO and NO packages. Samples are available now.

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ELECTRONICS NEWSLETTER

DATA GENERAL FIRES THE FIRST VOLLEY IN ITS RISC CAMPAIGN...

The first Data General Corp. systems based on reduced-instruction-set computing are hitting the market—four work stations and a server, all built around Motorola Inc.'s 88000 CMOS microprocessor. The RISC-based platforms run the Unix operating system, marking the Westboro, Mass., computer maker's first departure from its proprietary MV/Eclipse family. The initial RISC units run DG/UX, Data General's variation of Unix, which incorporates a new kernel designed to support symmetric multiprocessing. The firm says the entry-level unit, a diskless model with a 20-in. monochrome display and 4 Mbytes of memory, is priced "well below $10,000," which positions it against low-end, mostly PC-based work stations. But look for more sophisticated versions to start showing up as Data General moves against its arch-rival, Digital Equipment Corp., into the work-station market. Data General's advantage is that it can price aggressively because it has no installed base to protect. ☐

...BUT SANYO/ICON BEATS IT TO MARKET WITH AN 88000-BASED SYSTEM

Data General barely lost the race to send the first commercial computer using the Motorola Inc. 88000 RISC chip to market—Sanyo/Icon International Inc. got there first. The Orem, Utah, company unveiled its Model 8000 late last month, a week before Data General's announcement. The three-processor Sanyo/Icon system boasts a single-central-processor speed of about 15 million instructions/s and a double-precision whetstone rating of 6.75 million. Prices start at $155,000. The most likely competitors include DEC's midrange VAX units, plus Pyramid and Sequent computers. ☐

IEEE JOINS THE CALL FOR GOVERNMENT-BACKED CONSORTIA

Adding its voice to the American Electronics Association and other industry groups, a study group assembled by the Institute of Electrical and Electronics Engineers is calling for not just one, but several government-aided research and manufacturing consortia. These public/private joint ventures would address both research and development and full-scale manufacturing in two "crucial" areas: dynamic random-access memories and high-resolution systems. "You simply can't do R&D and then stop," says Alan McAdams, associate professor of managerial economics at Cornell University's Johnson Graduate School of Management and the chairman of the study group. "You've got to integrate manufacturing." He says that Sematech, a consortium working to produce advanced manufacturing know-how for the semiconductor industry, is "in no way a solution to the U. S. semiconductor manufacturing problem," but merely a "highly desirable first step." He thinks the government should quickly put in place economic incentives that will attract domestic firms back into the commodity-chip business, or risk losing its stake in supercomputing and other leading-edge technologies. ☐

HEAD SHRINKING ISN'T THE ONLY WAY TO MAKE A DISK DRIVE SMALLER

One way to make smaller disk drives is to shrink the head. Imprimis Technology Inc., a Minneapolis disk-drive maker, has come up with another: reduce the size of the sliders for the head mechanism, rather than the magnetic element itself. The sliders in the company's 70 Series thin-film head assemblies are about two-thirds smaller than those in today's thin-film-head drives. That means they'll help deliver faster access times and higher drive densities, thanks to lower restrictions on head flying height and less stacking space for multiple heads and disks. Imprimis has been providing samples of the new head assemblies to drive makers since late last year. Some 100,000 units should be produced in 1989 starting around midyear. ☐

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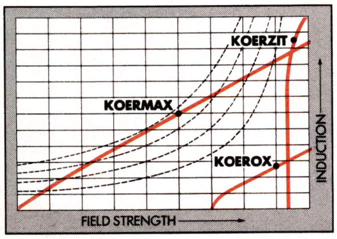

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PRODUCTS TO WATCH

TI'S 1-MBIT EPROM DELIVERS 20-NS STATISTICAL ACCESS TIMES

Forget high-speed cache memories and wait states as the only solutions to the problem of microprocessors outrunning the memories that store their code. The 20-ns average access time of Texas Instruments Inc.'s 1-Mbit erasable programmable read-only memory is fast enough to handle the job, and TI's BurstMode EPROM does it with clever circuitry—not new technology. Key elements include a standard 1-Mbit, 1.4-μm CMOS array and a 256-bit line buffer that acts as an on-chip cache, loading sequential data from the 1-Mbit array before the microprocessor needs it. Hit rates—the probability that the right data is stored in the line buffer—are about 90%. Other circuitry handles recoveries after misses, which means a 70-ns access time. Unveiled at last month's International Solid State Circuits Conference in New York, the BurstMode EPROM will be available by the end of 1989. ☐

ENCORE'S SUPERMINIS PUSH THE COST OF PROCESSING DOWN TO $3,500 PER MIPS

The Multimax 500 family of Unix-based parallel-processing superminicomputers from Encore Computer Corp. of Marlborough, Mass., represents one of the first applications of National Semiconductor Corp.'s 30-MHz NS 32532 central-processing unit. Encore's symmetric multiprocessors incorporate a CPU board that features two 532s, each of which executes 8.5 million instructions/s or 17 mips per board. As many as 10 boards can be linked—at less than $3,500 per mips—to apply 170 mips to both technical and commercial applications, ranging from software development and simulation to database management and on-line transaction processing. Available in July, a minimal 17-mips Multimax 510 system will sell for $159,000. A similarly priced Digital Equipment Corp. VAX 6300 delivers about 5 mips. Besides the VAX line, Encore says the Multimax 500 family will also compete favorably with Prime Computer's 6550 and Data General Corp.'s MV/40000 lines. ☐

STAC IMPLEMENTS ITS 2 : 1 DATA-COMPRESSION ALGORITHM IN HARDWARE

Makers of disk and tape drives who use data compression to effectively double the capacity of their memory products can now offer high performance as well with STAC's single-chip processor. The 9703 implements the company's 2 : 1 data-compression algorithm and gives at least a thirtyfold boost in the data-transfer rate, compared to software implementations. It gobbles up incoming data at 500 Kbytes/s and puts its compressed output on tape or disk at 250 Kbytes/s. Simulations by the Pasadena, Calif., company show the hardware implementation running more than 30 times faster than an Intel Corp. 80386 processor running the software package. Available next quarter, the chip, intended for QIC-type tape drives, will sell for about $50. ☐

NEC'S V80 DELIVERS 17-MIPS PEAK PERFORMANCE

Running at 33 MHz, NEC Corp.'s top-of-the-line V80 32-bit CISC microprocessor delivers a peak performance of 16.5 million instructions/s—2.5 times the performance of NEC's V70 and five times the 16-bit V60. In benchmark tests using the Gibson mix, the V80 delivers 13.1 mips. The chip, which also comes in a 25-MHz version, gets its speed from a seven-stage pipeline architecture and by integrating 1 Kbyte of cache memory for instructions and 1 Kbyte for data. Other architectural features include branch prediction and virtual memory management. Address- and data-bus error detection are provided for nonstop multiprocessor designs. Fabricated in 0.8-μm two-aluminum-layer technology, the 930,000-transistor circuit fits on a 14.49-by-15.47-mm chip. Sample prices are about $960 for the 25-MHz version and about $1,200 for the 33-MHz chip; look for a 45-MHz, 22.5-mips version in 1990. ☐

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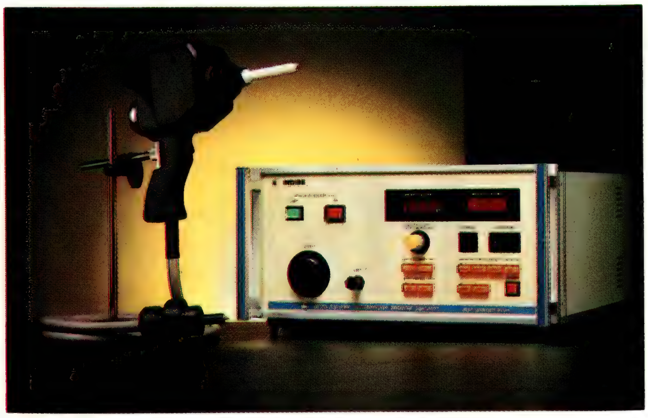

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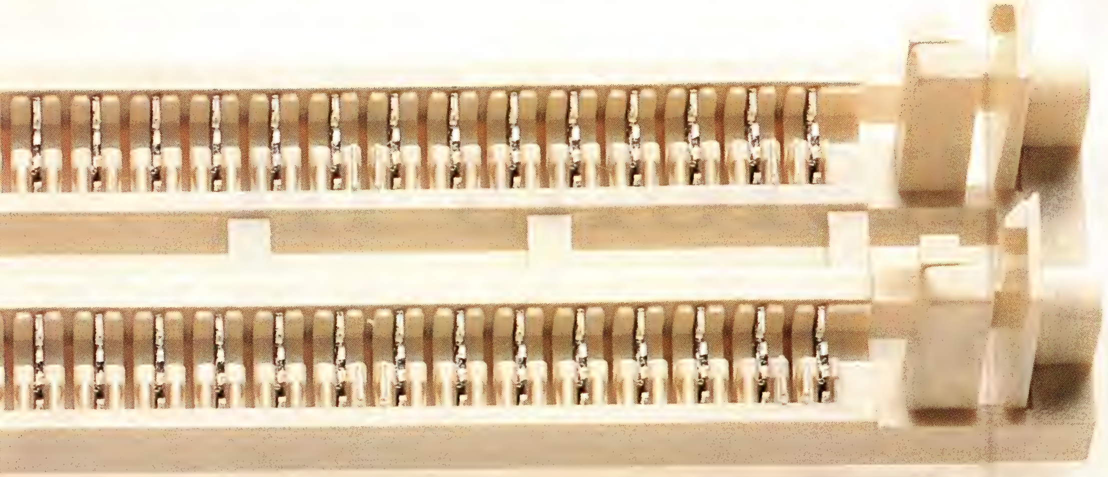

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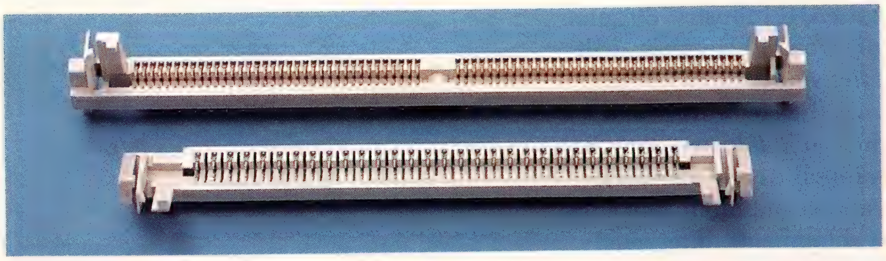

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Circle 24

INTEL'S ISSCC BOMBSHELL: A SUPERCOMPUTER ON A CHIP

The 80860 may revolutionize the way work stations are built

SAN JOSE, CALIF.

Intel Corp. has dropped a bomb on the work-station market: a reduced-instruction-set-computer chip that is no less than the silicon equivalent of a Cray 1 supercomputer. It could mean that designers laboring on the next generation of RISC work stations based on Sparc, MIPS, Clipper, or 88000 central-processing units are going to have to start over.

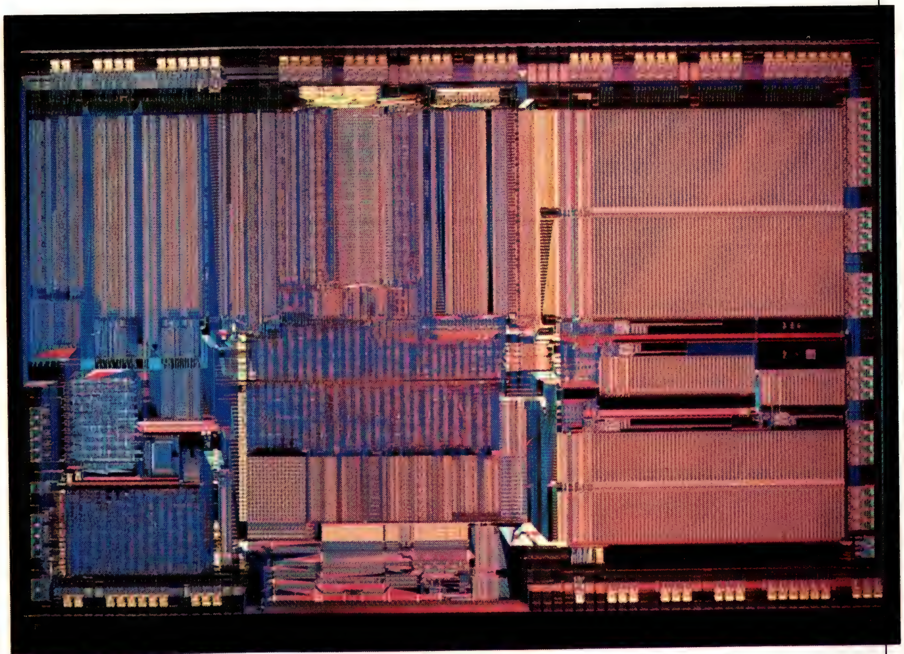
The reason: Intel's chip, the 80860, does right now what the others had hoped to do by year's end. It integrates integer processor, 64-bit floating-point unit, data and instruction caches, and memory-management unit on one chip. It then adds a powerful three-dimensional graphics processor to boot.

The 80860, up to now known as the N10, sets a new benchmark in supercomputer applications. Running at a 40-MHz clock speed, the chip delivers 33 million VAX instructions/s running the Stanford test suites, 10 million floating-point operations/s on the Linpack benchmark, 90,000 Dhrystones, and 500,000 4-by-4 vector transforms/s performing a graphics operation. In addition, it has been designed for multiprocessor operation, so the company has multiprocessor Unix development under way to support it. If all that weren't enough, Intel will start selling the 80860 before the year is up for $750 in 1,000-unit lots—a supercomputer on a chip at an affordable price.

The chip's commercial debut is bound to light a fire under developers of RISC-based systems, because the 80860 will permit them to build supercomputer work stations that will sell for less than $10,000. To help this effort along, Intel is providing a compiler in addition to starting the Unix development. Meanwhile, original-equipment manufacturers—IBM Corp. is probably among them—are already designing systems with the chip. Computer makers find the 80860 appealing because its individual processors—integer, floating-point, memory-management and cache, and graphics—can all compute simultaneously.

On the marketing side, shipments of RISC microprocessors in work stations have so far been far from breathtaking compared with those of complex-instruction-set chips such as Intel's 80386. Alice Leeper, senior analyst at Dataquest Inc., a market-research firm in San Jose, Calif., predicts that 600,000 RISC processors will sell this year, with the total growing to 6 million units in 1992. By contrast, she says, 8.3 million CISC processors will ship in 1989, growing to 26.3 million in 1992.

What is needed to narrow the gap is a high-performance, low-cost RISC chip that will spur work-station unit shipments, and that can be used in embedded-control applications. That's the 80860.



Intel's blockbuster 80860 is likely to goose the work-station market, because it will permit system houses to build $10,000 supercomputer desktop machines.

"With the floating-point and graphics capability, the chip is ideal for high-end 3-d graphics work stations," says Bill Rash, advanced 32-bit microprocessor-marketing manager at Intel in San Jose. "It's also ideal for high-end engineering work stations performing simulations for solids and fluids as well as electrical-circuits modeling, and board and chip layout."

In either case, the chip threatens to leave work-station marketplace competitors in the dust. Semiconductor vendors such as Intergraph, MIPS, Motorola, and those making Sparc CPUs have been making do with multiple-chip solutions using 32-bit-wide architectures. Work-station vendors using other chips will also be at a cost and size disadvantage compared with those using the 80860. "With this chip, a designer can build a Cray 1 supercomputer in a small-footprint desktop system for under $10,000," says Rash.

Rash cites the example of work-station manufacturers already offering diskless machines for less than $10,000 complete with high-resolution color graphics, a 1,000-by-1,000-pixel color monitor, and 8 Mbytes of random-access memory. "It's possible to build such a system with the 80860, which provides the graphics capability as well as the high-performance vector- and scalar-computing capability, and offer the system at the same price," he says.

The CPU cost with the 80860 will be considerably less than with the other RISC alternatives. A comparison made by Michael Slater, editor and publisher of the industry newsletter *Microprocessor*

CPU in its RISC-based computer away from its own proprietary architecture," he says. "I could see IBM building a high-performance graphics subsystem using the [80860] as a graphics accelerator. That way IBM retains the main CPU but gets much higher graphics performance at the same time."

Slater believes that Intel's original intent was to bundle the upcoming 80486 with the 80860. "If the [80860] is used as only a graphics accelerator, it is easier to incorporate into a system," he points out. "A graphics kernel can be written for it and then applications software can take advantage of its performance without making the investment in applications-software development that would otherwise be required."

The chip comes with a RISC integer CPU, single- and double-precision pipelined vector floating-point processors (a separate adder and multiplier), 3-d graphics, 4-Kbyte instruction and 8-Kbyte data caches, and paged memory-management unit. It uses a 64-bit data and instruction bus to execute more operations per second. With such a wide data path, the computer can load a 32-bit integer and 32-bit floating-point instruction, which execute concurrently in a single clock cycle.

Moreover, because the unit has separate multiplier and adder, a multiply-and-accumulate operation can occur in a single clock cycle as well.

At one company that has seen the 80860, Stellar Computer Inc. of Newton, Mass., vice president Michael Sporer says the idea of fetching a 32-bit integer instruction and a 32-bit floating-point instruction at once "is a fundamentally good idea. We implement that in our machine and I see more and more people doing it."

It's a safe bet that IBM is one of the OEMs that has had a peek at the 80860

In addition, the graphics processor can operate on bytes of data, a powerful feature for handling color. In one instruction cycle, the unit can individually process the values to drive the red, green, and blue guns of a color monitor and still have a byte operation to spare. But raw processing power is useless unless processors can rapidly acquire data to feed these units.

The 80860 has a system of buses that could not be implemented easily on a printed-circuit board with discrete processor chips. "A 64-bit bus feeds instructions to both integer and floating-point processors," explains Intel's Rash. It transfers 320 Mbytes/s of data. Another bus running between the data cache and the floating-point unit is 128 bits wide and can move 640 Mbytes/s. The external bus to the DRAMs is 64 bits wide and can transfer data at 160 Mbytes/s. "Altogether about a gigabyte of data can flow around the chip at any one time," he says.

While the chip uses a split instruction and data bus internally, externally it uses a standard 64-bit-wide bus for connecting to standard DRAMs. The bus transfers a data item every other clock, but with interleaved banks of DRAMs, all three banks can access data at once.

In addition to wide buses, the chip comes with architectural features to improve performance of its various processors. Leslie Kohn, chief architect, says his team applied some of the techniques that were developed for supercomputers to handle large data structures that did not completely fit inside the cache. Large data structures require many random accesses to memory. In a system with three banks of memory, for example, a structure could span all three.

"We have special instructions for performing pipeline accesses of large data structures, called pipelined floating-point load, in which the data is brought directly into the floating-point hardware without going through the on-chip cache," Kohn explains. The pipeline floating-point load

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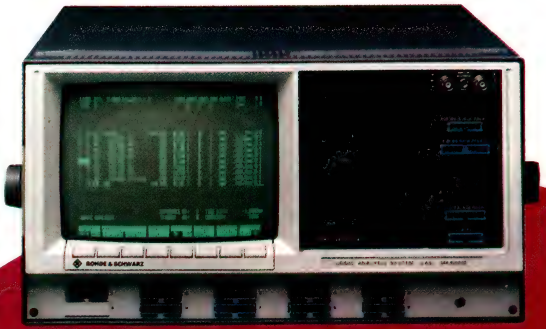
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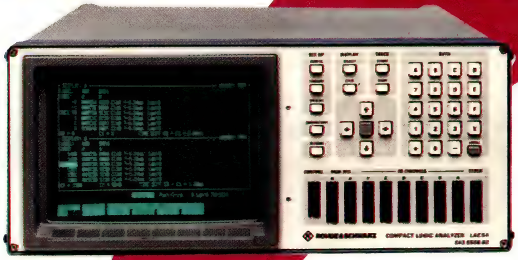
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Circle 18

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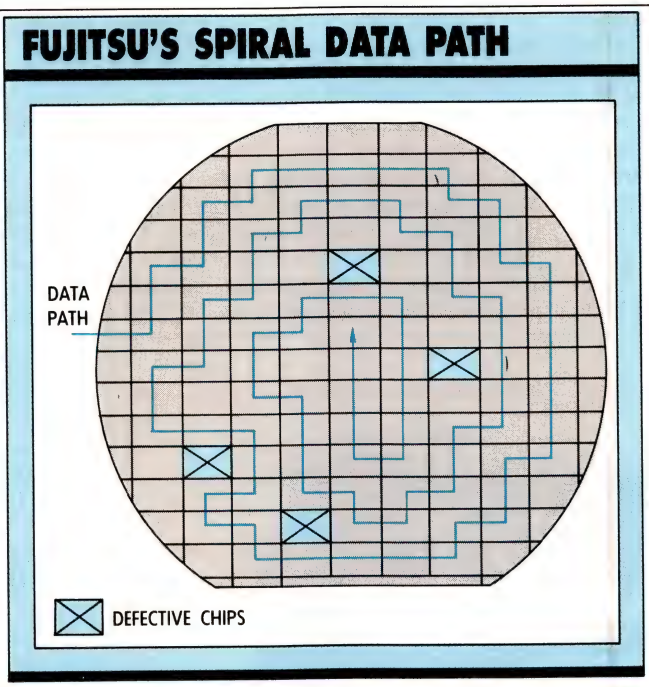
have samples of 4-Mbit models begun appearing than designers are ramping up for the next generation of 16-Mbit designs. Three Japanese companies—Mitsubishi, NEC, and Toshiba—are aggressively looking to slice off this territory as their own.

The Mitsubishi Electric Corp. design is especially interesting. As if using traditional methodologies of 60-ns access time and 120-ns cycle time weren't enough, the Itami-based company's device also incorporates an on-chip multipurpose register that slashes access time for a limited number of bits to 15 ns. For its part, NEC Corp. of Sagamihari uses a proprietary latched sensing scheme to push access time on its chip down to just 55 ns.

And pushing row access time even lower, to 45 ns, the design from Toshiba Corp. of Kawasaki uses a combination of process improvements and circuit enhancements. The starting point is a CMOS process with three p-wells and a trench-type capacitor cell. The internal array is broken up into 64 subarrays, each 256 Kbits in size, reducing word-line delays as much as 2 ns per subarray. Users can also selectively activate eight of the 64 subarrays when operating power needs to be reduced.

The design options with these parts, which store the equivalent of 2 Mbytes of memory on a single chip, are enormous. They create four to five times the memory that can be crammed into a standard personal computer available on eight to 16 DRAMs or SRAMs with today's commodity parts. Assuming that future generations of the MS-DOS and OS/2 operating systems can be modified to handle it, the same number of sockets now available for a PC would be able to incorporate up to 16 Mbytes of DRAM, the limit in 32-bit central-processing units for directly accessible memory.



Fujitsu's 200-Mbit wafer-scale serial memory is built around a core of operative and partially defective DRAMs.

From the system point of view, a harbinger of things to come in memory design is a 200-Mbit wafer-scale single-ported serial memory from Fujitsu Ltd. of Tokyo. The device was developed in cooperation with engineers from Anamartic Ltd. of Cambridge, England. Made with a standard 1.3-μm CMOS process, the wafer contains a DRAM core of 1-Mbit dice in which fully operative and partially defective DRAMs are interconnected using logic modules configured as electrically programmable read-only memories.

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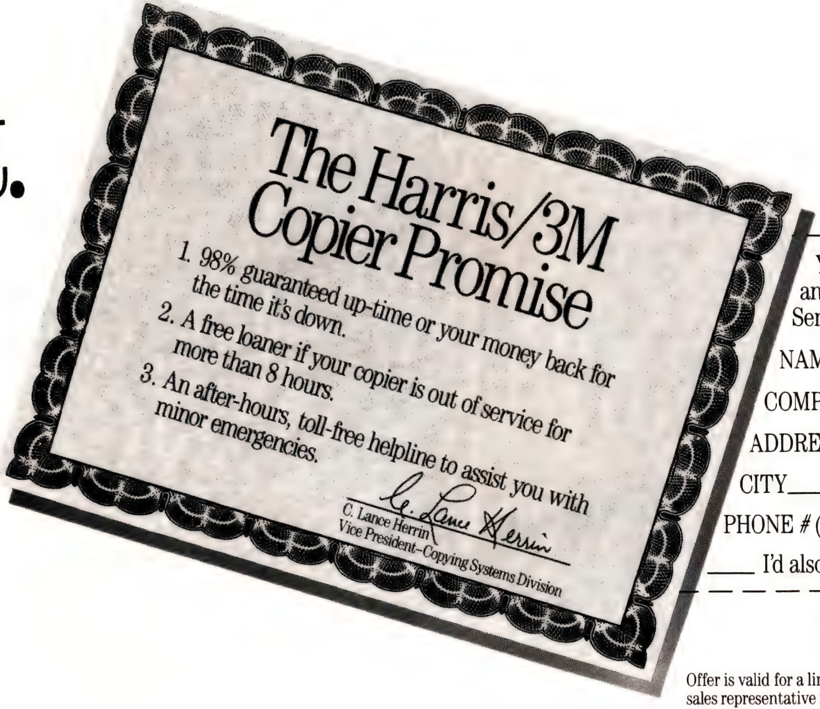

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WINDS OF CHANGE BUFFET DISTRIBUTORS

LOS ANGELES

The death in December of Anthony R. "Tony" Hamilton, chairman of Avnet Inc., could in coming months have more significance than the passing of a major industry figure usually does, mostly because of its timing.

More than three decades ago, Hamilton, who was respected even by competitors because of his upbeat outlook and accomplishments, single-handedly invented electronic-parts distribution as practiced today. Moreover, his brand of management—featuring heavy emphasis on salesmanship—built the flagship of distribution, Hamilton/Avnet Electronics. With some $1.4 billion in sales, the Culver City, Calif., company has set the pace for a business that topped $8 billion in the U. S. last year.

Distributors have been beset by many troubles in recent years, even during the chip boom of 1986-88. Today, their disappointing financial results reflect how tough things have gotten. So Hamilton's death, coming at a point when many executives and analysts believe that some fundamental changes have to take place, could hasten those changes.

DOMINO EFFECT. Even Hamilton's own company is not immune, industry observers say. They now single out as weaknesses the once-acknowledged strengths of Hamilton/Avnet, notably its nationwide scope and so-called "broad," or multiple-product, lines. Any basic changes at the firm will produce a domino effect for other companies, which must deal with Hamilton/Avnet because of its size and influence. It's still the largest U. S. distributor, followed by Arrow Electronics Inc., Melville, N. Y., and Lex/Schweber Electronics Inc., Westbury, N. Y.

For the time being, while Hamilton/Avnet management assesses where it stands, the official stance is only "growing concern for the bottom line," in the words of Edward Kaniger, senior executive vice president. Kaniger is running operations and reports to Leon Machiz, the former Avnet president who has taken over Tony Hamilton's corporate role. Both executives have vast experience and respect in the business, but outsiders note that "the company has Tony's stamp on it from top to bottom."

But it seems clear that "there will be some changes, because the mantle of leadership has passed to a different person," says financial analyst Clarke Walser of the Chicago Corp., Chicago. Others in the industry are less diplomatic; they say flatly that Hamilton/Avnet must change to keep up with competitors. Walser points out that Hamilton/Avnet "for many years took advantage of its size," using it for buying clout with suppliers, which often translates into a price edge for customers. But events of the past business cycle, and disruptions in the semiconductor business itself, have made these largely a thing of the past. One effect is that smaller rivals have successfully chipped away at Hamilton/Avnet's markets, which are served by 53 franchised locations.

The bedrock issue confronting distributors today—and especially Hamilton/Avnet, which some believe has grown too

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modity chips to flourish as well, because of ASICs' price premium in the form of nonrecurring engineering costs. "If you're only going to build a few machines," says Ball, "there's just no reason to jump into ASICs."

Although Wyle, Anthem, and several others continue to find success by narrowing their focus, there are still some holdouts doing well with broad lines. Gordon S. Marshall, of Marshall Electronics in El Monte, sees little reason to go charging off into new things. In his view, the troubles stem from the fact that many distributors simply "do a terrible job." Poor business practices such as allowing runaway costs explain much of the disarray, he says. Then, too, "there are too many of us [distributors]." Marshall credits his firm's success to "working at being the low-cost producer," and rivals agree than he runs the most efficient operation in the business. The tough-minded Marshall also is the only national firm to handle major Japanese lines, which make up about 25% of its $500 million-plus sales.

LOOKING EAST. Other distributors have their eye on how that market—as well as the distribution strategy for Korean components—will develop. The market presence of Japanese and Korean chip makers "is most clearly felt in memories and particularly dynamic random-access memories," says Ball. Like other distributors, Semispecialists tends to put the onus of selling foreign parts on the U. S. chip makers by saying that if the domestic semiconductor houses "choose to create a void, we're considering going somewhere else." Chips from Far East sources seem likely to become "increasingly a factor as time goes on," says Ball, "but I don't think they will be ubiquitous."

Along with questions about the course of events at behemoth Hamilton/Avnet, many industry executives worry that a recession will force unwanted changes on everybody, just as the chip downturn did in 1985. At that time, several firms disappeared, including one of the top 10, Kierulff, which was acquired by Arrow. If bad times do come in the next year, companies with big debt loads, such as Arrow and Hall-Mark Electronics Corp., Dallas, could be most vulnerable, says the Chicago Corp.'s Walser. In fact, Hall-Mark was the subject of a $220 million leveraged buyout last year.

Marshall, who has seen chip cycles come and chip cycles go, is certain a recession is on the way. But he sees any resulting downsizing of distribution paradoxically serving to improve the business later. That's especially true for firms such as his that have strong finances, he says, and can weather the storm. "That's not gloom and doom," he says, "but realism." *–Larry Waller, with additional reporting by Jack Shandle*

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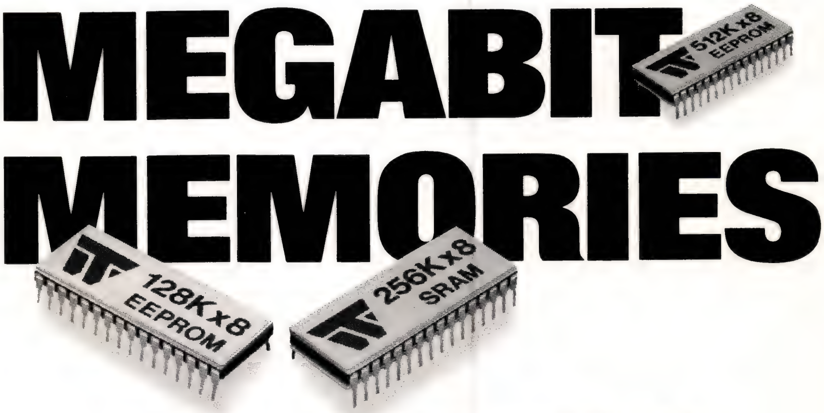

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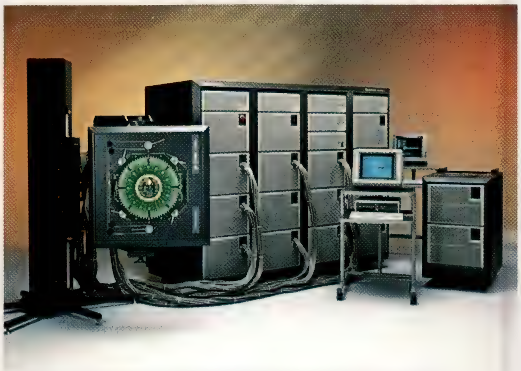

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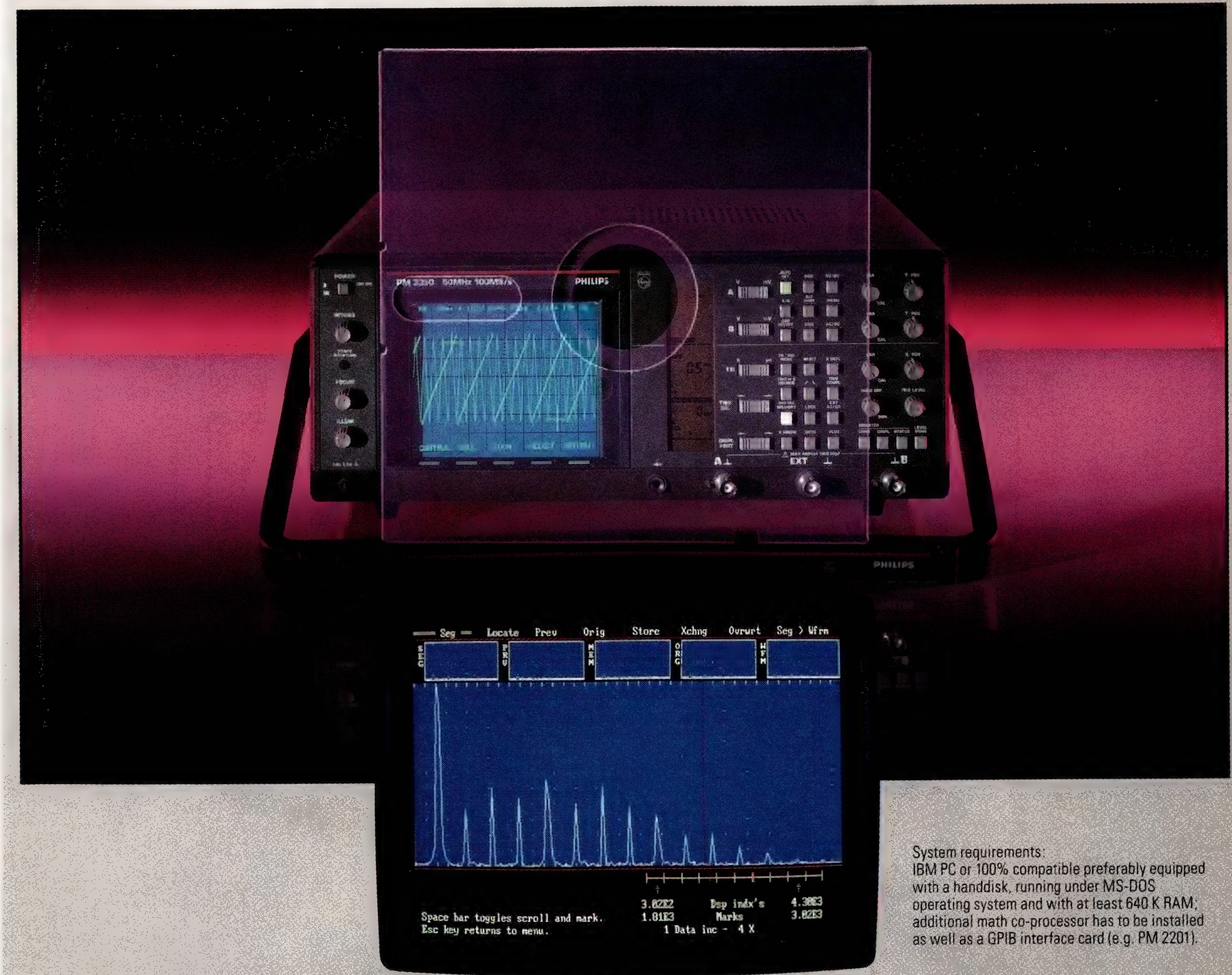

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Esc key returns to menu.                1.81E3        Marks         3.82E3
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System requirements:
IBM PC or 100% compatible preferably equipped with a handdisk, running under MS-DOS operating system and with at least 640 K RAM; additional math co-processor has to be installed as well as a GPIB interface card (e.g. PM 2201).

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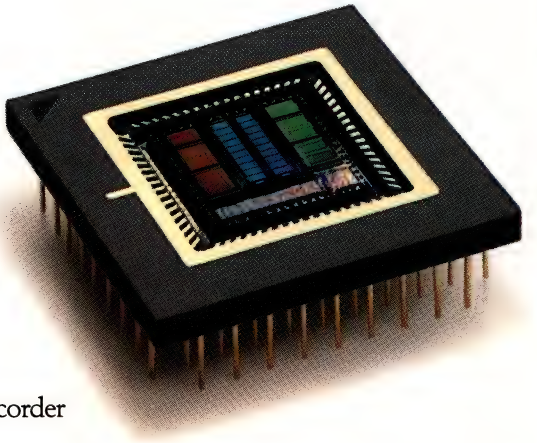

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Circle 13

MEDICAL ELECTRONICS

HERE COMES A TRIPLE-BARRELED HEARING AID

ERLANGEN, WEST GERMANY

They haven't put them in antiques shops yet, but that's where today's hearing aids might as well be. That's because Siemens AG has come out with the Triton, a hearing aid that could make conventional versions as obsolete as the ear trumpet.

Due to hit world markets this fall, the Triton has three independent amplifier channels with characteristics that can be precisely adjusted to the user's hearing condition. At its heart is a CMOS chip in the device's behind-the-ear housing that stores the settings for various parameters such as gain and dynamic response. These derive from a digitally controlled programming unit that can be set for the greatest perception of speech and the least perception of background noise.

But what makes the new hearing aid unique is its three-channel design, which contrasts with the single-channel approach generally used in conventional hearing aids. In the Siemens product, there's one channel each for low-, medium-, and high-frequency sounds—hence the name Triton. "Having three separate channels is the key to accurate adaptation to a person's hearing problems," says Herbert Wolf, deputy chief of the hearing-aid-development section in Siemens' Medical Electronics Group in Erlangen.

ATYPICAL DESIGN. The typical approach to hearing aids involves adapting the frequency characteristics, amplification properties, and dynamic response to each person's hearing loss. Volume-control systems such as automatic gain control (AGC) regulate the dynamic range to ensure comfort for hearing-aid wearers, who are usually sensitive to amplified noise but unable to do much about it. With conventional single-channel devices, if the AGC is set to optimally receive high-frequency sounds, the setting may be inadequate for medium-frequency and useless for lower-frequency sounds, where most background noise lies.

But the Triton divides the frequency range into three segments and then separately amplifies each one. Dynamic range control for each channel greatly improves speech perception and virtually eliminates noise components.

Because of this the Triton can treat the higher- and lower-frequency sounds differently, and that's significant for the hard-of-hearing. They generally perceive low-frequency sounds fairly well, so the low-frequency channel needs little, if any, amplification. Medium-frequency sounds usually require more and high-frequency sounds need the most amplification, because the hearing-impaired generally have problems perceiving higher-frequency sounds. With single-channel aids having only one control or setting for the entire 200-to-6,000-Hz range, an optimum setting for, say, the medium-frequency sounds may be totally ineffective for the high- and low-frequency sounds.

Siemens' Triton hearing aid undergoes complex acoustical tests and measurements in a soundproof room before it will go to market this autumn.

Besides separation, the Triton has still another advantage. Each channel has its own signal-buildup and decay-time characteristics for the AGC. In contrast to conventional single-channel devices, it can shut out the abrupt increases in volume caused by sharp crackling noises and detonations.

In addition to the amplifier stages, the CMOS chip in the behind-the-ear housing has switched-capacitor filter circuits and electronic controls. The controls are for as many as eight parameters as well as for memory to store the eight settings for these parameters: gain and dynamic response for each of the three channels and the two frequency values that separate and identify the three channels.

The chip operates on only 1.3 V. To set up the Triton, the acoustician connects the device to a microprocessor-controlled programming unit. Once the eight parameters are set, they are stored digitally in the CMOS circuit. Even though the new device requires more circuitry than ordinary hearing aids, Siemens engineers managed to pack it into the conventional behind-the-ear housing. The programming device has a standard interface to transmit the settings to a computer for central recording and archiving. *–John Gosch*

TAKEOVERS

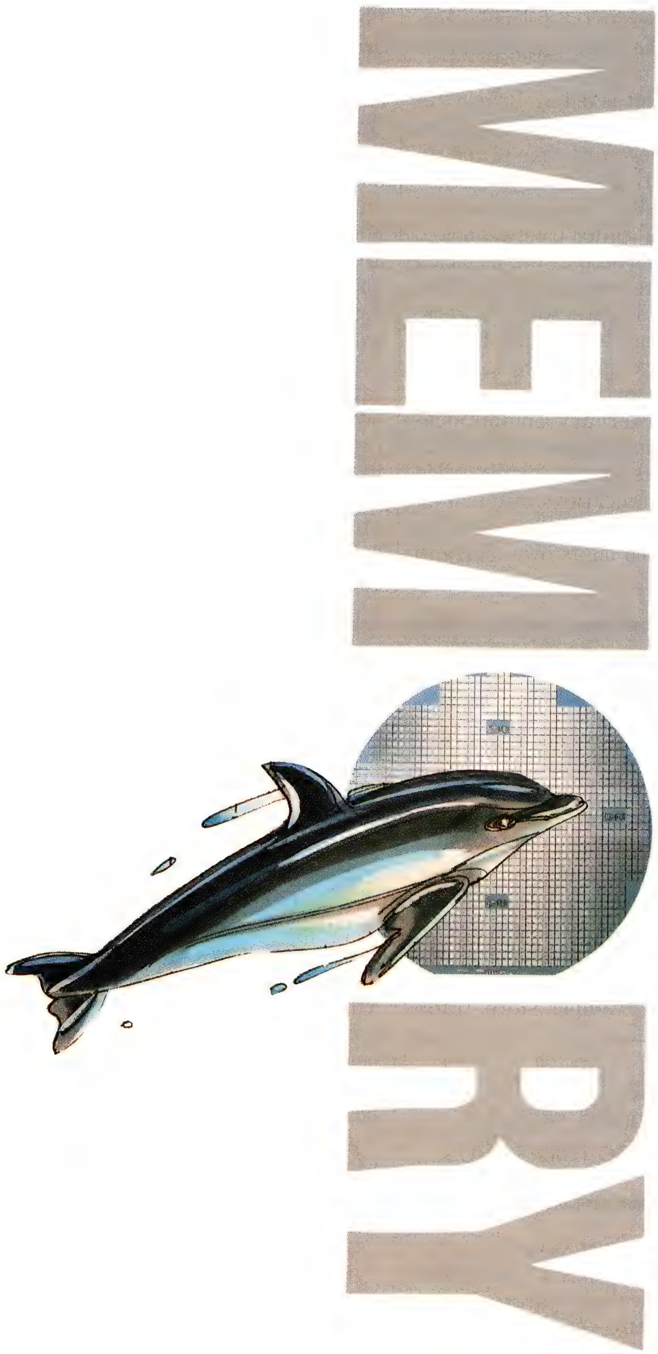
AN ELEVENTH-HOUR TWIST IN PLESSEY TAKEOVER BID

LONDON

Animosity between Plessey Co. and Britain's General Electric Co., already bubbling nicely over the past few weeks, is now reaching the boiling point. What turned up the heat was a sudden decision by GEC and its West German ally, Siemens AG, to drastically revise what they plan to do with Plessey should they succeed in their attempt to take over the British electronics company.

GEC-Siemens plc, the subsidiary set up by the two companies to make the takeover bid, had already laid out a set of plans in the various shareholder filings, court documents, and regulatory proceedings required at different stages of the acquisition attempt. Among these were filings with the British Monopolies and Mergers Commission, to which the whole matter was referred in mid-January. The commission was given three months to decide whether it would allow GEC-Siemens to proceed. Everyone expected the whole affair to simmer quietly on a back burner during that time.

But early in February, on the last day for filing evidence with the commission, GEC-Siemens announced that it had "decided to submit revised proposals with re-



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W2364	64K	8K× 8	200	80mA/20mA	28
W23128	128K	16K× 8	200	80mA/20mA	28
W23256	256K	32K× 8	200	80mA/20mA	28
W23512	512K	64K× 8	200	100mA/20mA	28
W231024	1M	128K× 8	250	100mA/20mA	28
W23C2048	2M	256K× 8	100	30mA/100μA	32
W22C2048	2M	128K×16	100	30mA/100μA	40
W22C4096	4M	256K×16	100	30mA/100μA	40

CMOS SRAM

TYPE NO.	ACCESS TIME max (ns)	ORGANIZATION (WORD × BIT)
W2416	100-150	2K×8
W2464	100-150	8K×8
W2464A	35-55	8K×8
W24256	100-150	32K×8
W2616A	35-55	16K×1

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HEWLETT
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WASHINGTON INSIDER

SDIO KEEPS CHIPPING AWAY AT DIAMONDS IN THE ROUGH

The Strategic Defense Initiative Organization thinks diamonds could be a satellite's best friend. Their naturally high band gap means diamond computer chips can withstand much higher temperatures than silicon or gallium arsenide—700°C compared with about 125°C. They can also tolerate far more radiation and operate at higher power and frequency, which makes them highly attractive for use in the satellites that would make up a Star Wars system. Cooling systems—now 65% of the average satellite's weight—could be made some nine times smaller and the cost of a launch slashed to a tenth of what it is now, says Dwight Duston, director of SDIO's Innovative Science and Technology office. SDIO accordingly is pumping more than $4 million a year into work on diamond-based chips. Its research shows that diamond circuits can be designed and built, but a major hurdle remains: growing diamond wafers. "Diamond has a hard lattice constant to match," Duston says—the 700°C-to-800°C temperatures being used to grow thin diamond films are too hot for the most suitable substrate materials, such as lithium fluoride, to survive. The Research Triangle Institute in North Carolina is scrambling to develop a copper-nickel alloy that could stand such temperatures; elsewhere, work is focusing on a low-temperature processing technique that would allow the use of lithium fluoride. If any of these pan out, Duston says, diamond chips could eventually be price-competitive with silicon—making them practical for commercial as well as military applications. ☐

SILICON CARBIDE DEBUTS AS AN APPROACH TO RAD-HARD CIRCUITRY

While SDIO officials are trying to make diamond wafers, a small company in Durham, N. C., next month will begin selling a family of diodes that exhibits many of diamond's properties. Cree Research Inc.'s high-power, high-frequency diodes use silicon carbide, which like diamond is a refractory material that can operate at very high temperatures—around 350°C—and in very harsh environments. The diodes also are inherently hardened against radiation. More important, SiC can easily support oxide layers, so unlike gallium arsenide it can be used to create MOS FETs—a basic building block in silicon chips. Working on a number of development contracts with SDIO, the Air Force, NASA, and the Navy, Cree plans to move up from diodes and eventually produce small- and medium-scale integrated circuits. ☐

THE PENTAGON GETS CLOSER TO GENERIC CHIP SPECIFICATIONS

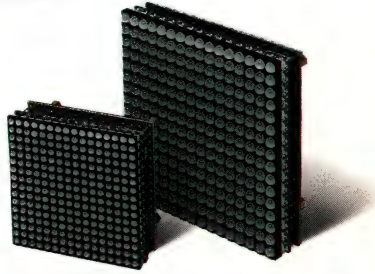
The Defense Department hopes to establish by summer a final version of a new "generic" specification that will radically alter the way the military buys integrated circuits. The spec, Mil-I-38535, aims to eliminate the costly and time-consuming practice of qualifying each chip individually by letting the Pentagon certify processes and manufacturing lines instead. Any part produced on a certified line would be fully qualified for military use. That should cut the time it takes to turn new technology into working chips on the DOD's Qualified Parts List. In the process it will make it easier for the military to use application-specific ICs. The new system will also relax requirements for government audits and end-of-the-line testing, allowing chip makers to take much more responsibility for their products. Not that making the new Qualified Manufacturers List will be a piece of cake—it's going to take extensive investment in quality and process controls, from design through wafer fabrication, assembly, and test. The Defense Electronics Supply Center in Dayton, Ohio, has already done a week-long preliminary QML audit at AT&T Microelectronics, and is also working with other interested vendors, including GE/Harris, IBM, Intel, LSI Logic, National Semiconductor, Texas Instruments, and VLSI Technology. ☐

Toshiba LED Module Achieves Delicate Display with 16-Gradient Control.

The forms and functions of information and its handling are diversifying with great speed. Toshiba, a world leader in the opto-electronics field, has developed a 16 × 16 LED dot matrix module that opens new possibilities in information display. By combining these modules, a display equivalent to that of a TV can be realized. By use of Toshiba's outstanding two-color LED together with its unique gate array for driving, 16-gradient control is achieved in this new product. Compact design makes the module lightweight and optimally thin. Unique heat radiation design greatly improves the dispersion of heat from the module, and connections are simple, ensuring freedom from maintenance. In applications ranging from simple messages to visual displays such as message boards, entertainment and projector use, Toshiba's LED module is a standout.

CHARACTERISTICS	DETAIL					
Type Name	TLMM501B2	TLGM501B2	TLSM501B2	TLMM502A1	TLGM502A1	TLSM502A1
Color Display*	Red, Green, Amber	Green	Red	Red, Green, Amber	Green	Red
Dot Size	⌀5mm			⌀3mm		
Dot Pitch	6mm			4mm		
Weight (Typ.)	170g	165g	165g	95g	85g	85g

*Amber color is made by a mixture of red and green.



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Circle 17

NUMBER 141

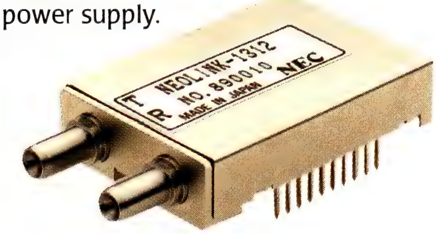
FDDI FIBER OPTIC TRANSCEIVER.

The American National Standard Institute (ANSI) is now compiling the standard for high-speed LANs. Called the Fiber Distributed Data Interface (FDDI), the new standard features a data rate of 125Mbps, 100km network coverage and up to 500 nodes.

NEC's NEOLINK-1312 is designed to meet or exceed FDDI-PMD requirements. The new 125Mbps fiber optic transceiver incorporates a 1.3μm LED, PIN-PD and two LSIs. These are the same components used in our 200Mbps datalinks (NEOLINK-2012). Over 60,000 pairs of the 200Mbps link have been shipped since 1985 without a single field failure.

The new NEOLINK-1312 features a transceiver configuration designed for easier mating with an MIC duplex connector. The design eliminates the need to painstakingly align separate transmitter and receiver units on a printed wiring board. Crosstalk and noise problems are also solved with our circuit and isolation expertise.

The NEOLINK-1312 offers an average output power of −16dBm; average receiving power between −34.5 and −13.0dBm. It operates on either a single +5V or −5.2V power supply.



NEW SOLID-STATE TV TRANSMITTERS: UP TO 40KW IN UHF.

Solid-state TV transmitters are fast replacing tube types because they are more reliable, economical and easier to maintain.

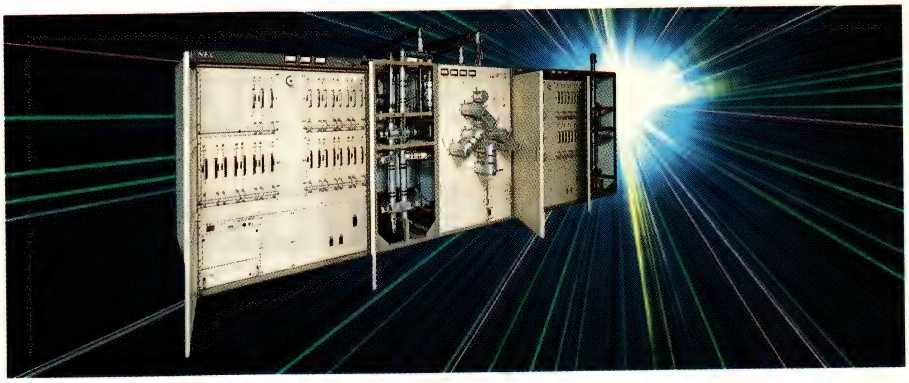
The all solid-state transmitters of NEC's new PCU-900 series incorporate the latest semiconductor and RF circuit technologies. We offer five models for UHF broadcasting: 5/10/20/30 and 40kW.

All models use 800W PA modules and 110W power transistors specially developed by NEC. All adjustments are handled automatically by a high-performance synthesized exciter.

Reliability is enhanced by parallel use of power transistors and PA modules. Increased stability handles voltage fluctuations of ±10% without AVR.

Since the transmitters operate on 28V DC power, they provide greater safety and require less maintenance. Power transistors are efficiently cooled by our "Jet Air Cooling" system.

NEC also supplies a series of fully solid-state transmitters for VHF broadcasting. Our PCN-1400 series has five models: 5/10/15/20 and 30kW.



VAST LIBRARY SYSTEM FOR CHINA.

NEC is supplying a large-scale information system to the National Library of China (NLC) in Beijing. With over 14 million volumes in its collection, the NLC is one of the world's largest libraries.

The library system for the People's Republic of China consists of two mainframes for database management and 270 personal computers for terminal applications. The system will handle 56 languages and allow retrieval of millions of books in each language by category and author listing.

The NLC and NEC are jointly developing Chinese-language software for the system. The software will meet China's new national standard of 32,000 characters. The library system will be in full-scale operation in mid-1991.

Since the NLC is one of China's academic centers, it will use the system in the future as the core of a network linking thousands of libraries around the country.

NEC

PACIFIC RIM TRENDS

FUJITSU AND HITACHI PLUG AWAY AT JOSEPHSON-JUNCTION WORK

It is unlikely that those odd ducks of the semiconductor barnyard, Josephson junction processors, will be the basis of a complete superconductive system any time soon. Moreover, the difference in temperature and the long leads between the liquid-helium environment and semiconductor processors create a time delay that makes JJs difficult to use where data must be exchanged with semiconductor circuits. However, none of this would be a problem in applications such as code conversion in multigigabit/s communications circuits. The JJ could also be used as a form of front- or back-end processor for another computer. For those reasons, development work continues, and researchers at Fujitsu Ltd. and Hitachi Ltd. are reporting progress. Those at Fujitsu have built a JJ processor with a 4-bit microprocessor core logically equivalent to the Advanced Micro Devices Inc. 2901, a 4-bit-by-4-bit multiplier, a 12-bit accumulator, an 8-Kbit program read-only memory, and a sequencer. The chip has 24,000 Josephson junctions fabricated in 1.5-μm-diameter niobium aluminum-oxide niobium technology. Fujitsu says it will take three to five years to develop a prototype. At last month's International Solid State Circuits Conference in New York, Hitachi reported on a JJ processor, but with a lower level of integration and a lower speed. It uses technology similar to Fujitsu's but has 2.5-μm features. □

THE JAPANESE BUILD A SMALLER SYNCHROTRON FOR X-RAY LITHOGRAPHY

Japanese researchers now have a working synchrotron storage ring with superconducting magnets that's almost small enough to be used on a fabrication line for ultralarge-scale integrated circuits. The new storage ring provides the 7 Å unit-peak soft X-rays needed for lithography to fabricate devices with 0.2-μm or smaller design rules. The racetrack-shaped ring is at a Nippon Telegraph & Telephone Corp. office in Atsugi. At just 2.5 by 8 m, it accelerates electrons to the required 600 million electron volts, and the associated linear accelerator that injects electrons into the ring is only 1.7 m long. The normal-temperature-magnet ring the facility has used until now measures 15 by 15 m. □

SONY CHALLENGES SVHS WITH BETTER RESOLUTION IN 8-mm VCRs

Smaller is getting sharper in video-cassette recorders. Sony Corp. next month will start sales in Japan of a "high-band" 8-mm camcorder and video deck that offer the high horizontal resolution of more than 400 TV lines despite the small tape size. Resolution is comparable to the increasingly popular SVHS format (developed by Victor) and to studio equipment. The high-band format was adopted by 10 companies in March 1988. For high-band use, Sony will sell precision cassettes with two new types of tape, both of which record the TV signal in a semiperpendicular mode with a minimum wavelength of 0.49 μm. Evaporated-metal tape, said to be the first for video use, has a signal-to-noise ratio 5 dB higher than former tapes. □

NTT DATA AND NISSAN TO START SMART-CARD COMPANY

NTT Data Communications Corp. aims to ramp up the Japanese smart-card market in cooperation with giant auto manufacturer Nissan Motor Co. Ltd. of Tokyo. NTT Data, also in Tokyo, is the company recently spun out from Nippon Telegraph & Telephone Corp.; with Nissan it will establish a company in Tokyo in May to make the cards. The joint venture, whose name has not been chosen, will be capitalized at about $4 million—90% from Nissan and the rest from NTT Data. Its aim is to market a card developed by NTT Data that will target the owners of Nissan's vehicles. □

EUROPEAN OBSERVER

WEST GERMANY STARTS HOOKING UP ISDN ON A LARGE SCALE

Without much fanfare, West Germany's communications authority, the Bundespost, is introducing integrated services digital networks on a large scale. During the past few weeks, partial networks have started operating in Düsseldorf, Frankfurt, Hamburg, Hanover, Munich, Nuremberg, Stuttgart, and West Berlin. The Bundespost figures it will be offering ISDN service nationwide by 1993. In the meantime, the West German communications industry is bracing itself to handle the rising demand for terminal equipment that ISDN will create. The Bundespost is prepared to give up its monopoly on subscriber terminals by the middle of 1990, which will open the door to inexpensive hardware from the Far East and will spark fierce rivalry in the marketplace. To meet the competition, small West German equipment makers who now enjoy a secure market with one powerful customer, the Bundespost, are forming co-operatives to work on development and marketing strategies and to buy components in bulk. ☐

EUROPEAN PROJECT COMES UP WITH A BREAKTHROUGH TV SCREEN

Finland's Lohja Corp. is ready to produce a monochrome flat-screen TV with a 12-in. electroluminescent screen. The event marks an important milestone in the European Community's RACE program, for Research and Development in Advanced Communication Technologies in Europe. The screen, including the electronic circuitry behind it, is only 54 mm thick. That means it can be used to make radically different TV sets—models that can be hung on a wall, for example. The screen is the largest developed so far using EL technology, claims Jorma Antson, marketing manager for flat screens at Lohja's Finlux division. The monochrome prototype runs off a 12-V dc power supply and consumes only 20 W. Images are built up from sizes of 200 by 384 pixels, each pixel measuring 0.6 by 0.6 mm. The project's goal is a color version of the set, with commercial products available by the second half of the 1990s. Besides Lohja, the RACE participants include France's Matra Communications, the Italian-French combine SGS-Thomson Microelectronics, and the University of Ghent in Belgium. ☐

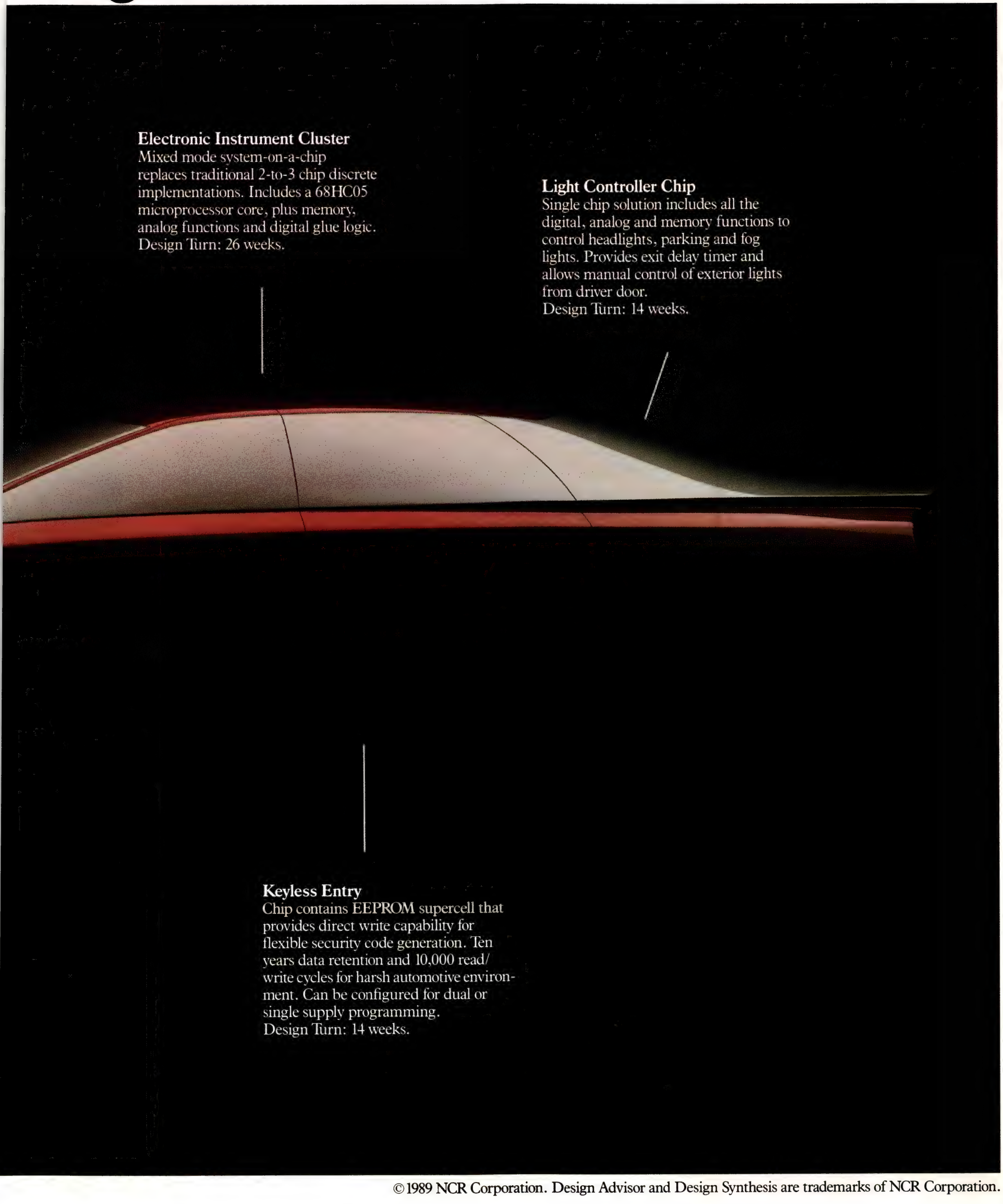
TEXAS INSTRUMENTS BUILDS A WAFER PLANT TO HANDLE PAN-EUROPEAN CHIP DEMAND

Texas Instruments Inc. is getting ready for increased chip demand when Europe 92, the tariff-free, unified European market, opens up. TI is building a wafer-production plant in Avezzano, 60 miles east of Rome, at a cost of $250 million. The plant should begin operating by the end of next year and working at full capacity by the middle of 1991. It will employ more than 500 people, who will turn out MOS integrated circuits, including dynamic random-access memories. Production will begin with 4-Mbit DRAMs; advanced MOS logic ICs will eventually follow. ☐

PROJECT AIMS FOR A 1-GIPS OBJECT-ORIENTED COMPUTER

Work is starting on a pan-European project called Tropics, for transparent object-oriented parallel-computing system, a machine intended to run more than a billion instructions per second. The project is scheduled to take five calendar years and about 700 man-years to complete, with the first phase taking some 210 man-years to produce a prototype. The finished Tropics will be made of hundreds of processors operating in parallel and is intended as a server on local-area networks handling complex office applications. Philips International NV of the Netherlands heads the project. Participating firms include France's Thomson-CSF, Italy's Olivetti, West Germany's Nixdorf, and a number of universities and research institutes. ☐

Style & Silicon.



Electronic Instrument Cluster
Mixed mode system-on-a-chip replaces traditional 2-to-3 chip discrete implementations. Includes a 68HC05 microprocessor core, plus memory, analog functions and digital glue logic.
Design Turn: 26 weeks.

Light Controller Chip
Single chip solution includes all the digital, analog and memory functions to control headlights, parking and fog lights. Provides exit delay timer and allows manual control of exterior lights from driver door.
Design Turn: 14 weeks.

Keyless Entry
Chip contains EEPROM supercell that provides direct write capability for flexible security code generation. Ten years data retention and 10,000 read/write cycles for harsh automotive environment. Can be configured for dual or single supply programming.
Design Turn: 14 weeks.

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Circle 8

U. S. electronics interests are scrambling for position in what could be a make-or-break effort. 'HDTV is more than just another TV set,' the AEA warns

UNITY ON HDTV

cur offshore, U. S. chip makers will find themselves in an increasingly weak position to sell into overseas markets or into products built in the U. S. by foreign manufacturers, the reasoning goes.

What's more, high-resolution flat-panel and cathode-ray-tube display technology developed for HDTV will find applications in defense, medical imaging, and computers, among other segments. As sophisticated HDTV products gain more and more processing power, they will begin to compete with PCs and work stations, some experts believe. And if the Japanese have a dominant HDTV position, they will leverage the volume to take PC market share from the U. S., the AEA warns.

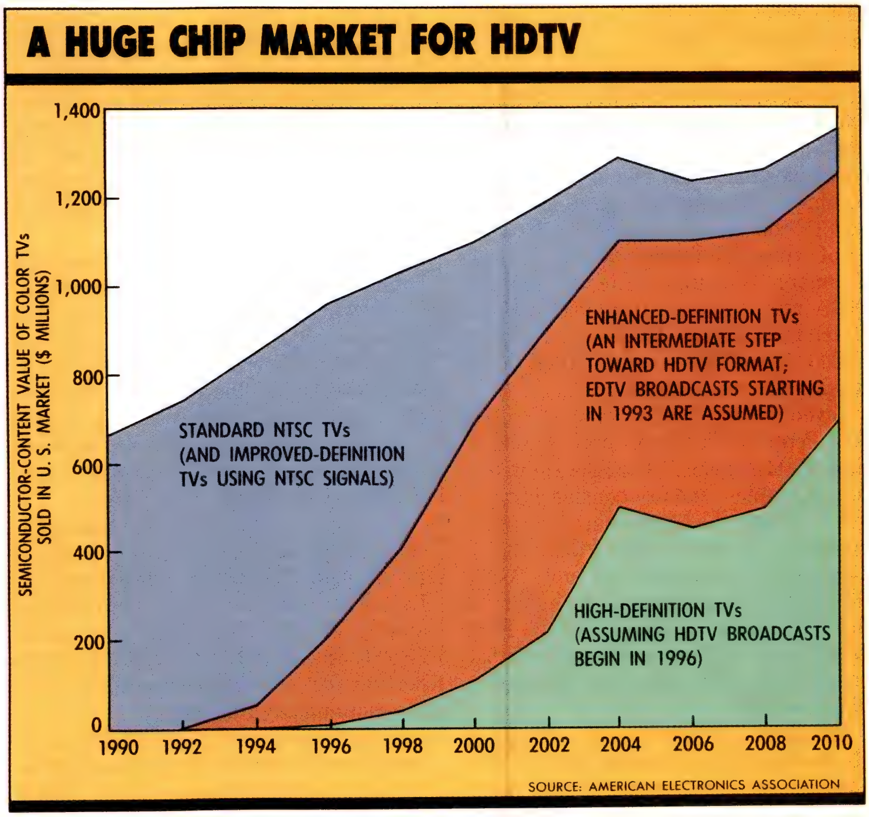
According to a working document issued by an AEA task force late last year, if the U. S. settles for controlling less than 10% of worldwide HDTV production, it stands to lose half of its current world-market share in semiconductors and PCs. To merely maintain its current share in both of these key segments and others, the U. S. needs to capture half or more of the HDTV manufacturing base, the AEA contends. In short, "HDTV is more than just another TV set," says Iverson.

Not all, of course, subscribe to the AEA line. "There's almost an HDTV hysteria today," says Larry French, a corporate vice president at North American Philips Corp., the New York-based arm of Philips International NV of the Netherlands. "It's becoming a symbol of what's wrong with the U. S. and [with] U. S. competitiveness." And the Electronic Industries Association—a Washington trade group with membership that includes foreign-owned consumer manufacturers—challenges many of the AEA's conclusions. The focus should not be on who owns the HDTV manufacturing, the EIA says, but rather on assuring the maximum number of U. S. jobs in HDTV production, research, and development.

But the AEA view is one that many in industry and government seem increasingly to be rallying around. Even the Pentagon is getting into the act. The Defense Advanced Research Project Agency is planning later this year to award $30 million in HDTV development funding aimed at display and video-processor technology. Bids on that effort were due Feb. 27.

The House of Representatives, meanwhile, is holding hearings on HDTV competitiveness, with an eye toward finding what's needed to foster a U. S. technology thrust. The idea of a consortium similar to the $100 million Sematech chip effort is being floated around. And now a special Commerce Department advisory committee has come out with a preliminary report stating that "lack of significant U. S. participation [in HDTV] would exacerbate the already dwindling U. S. industrial base in consumer electronics and adversely affect U. S. semiconductor, computer, and related industries."

In any effort to gain a major stake in the HDTV business, the U. S. is starting



A HUGE CHIP MARKET FOR HDTV

SOURCE: AMERICAN ELECTRONICS ASSOCIATION

standard "multiport" receiver with two inputs—one UHF/VHF for NTSC signals, the other a baseband port for HDTV. The baseband port could handle multiple standards for various media as long as those standards shared a "friendliness," or commonality, in certain baseband characteristics, such as frame rates, field rates, and aspect ratio.

This intense interest in multiple media stems from HDTV's potential to revolutionize home entertainment. HDTV receivers will display twice the horizontal and vertical resolution of today's NTSC sets, with 10 times the color-information detail, producing a picture quality equivalent to that of 35-mm movie film. It will deliver a cinema-like wide-screen picture, with an aspect ratio of 16 : 9 or 5 : 3, compared with the 4 : 3 NTSC standard. Multichannel wideband audio will round out the package, delivering crystal-clear stereo hi-fi sound, equivalent to that of a compact disk.

All this comes at a price: HDTV receivers will sell initially for $2,500 to $4,000 at retail. And there is always the chance that U. S. consumers won't take to the technology in sufficient numbers to drive volume pricing and create a mass market.

But based on an assumed $2,500 retail starting price, the EIA is predicting rapid penetration, with 10% of U. S. households owning one HDTV set four years after introduction. That would be a higher acceptance rate than for either color TV or VCRs. The EIA projects that Americans will buy 13 million HDTV receivers in the year 2003, 92% of which will be manufactured in the U. S., employing 232,000 workers and contributing $23 billion to the gross national product. The AEA is more conservative. It projects U. S. sales at 4.9 million units in 2003, producing a $2.8 billion market. The numbers climb to 11 million units and $6.6 billion by the year 2010.

Because no single U. S. firm would be likely to take on the high risk and expense of HDTV development and manufacturing on its own, most in the AEA camp agree that government involvement is a requirement. But what form that might take is still anyone's guess.

It might include new types of industry and government-industry consortiums. And it might include any combination of federal loan guarantees, tax breaks, relaxation of antitrust laws, new trade regulations, or stricter enforcement of the antidumping laws already on the books.

Not surprisingly, U. S. executives of foreign-based firms are playing down the need for a big federal spending program. "HDTV is really just a small part of a much larger problem," says French of Philips. Japanese companies dominate consumer electronics not because of technological superiority, he says, but because U. S. companies chose not to compete in an arena of low profit margins. "I see no reason to expect that this will remain anything but a competitive business with small profit margins. To see HDTV

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siders say those two steps alone could easily take another year or more.

"It could still happen in 1991," says Robert Hopkins, chairman of the FCC subcommittee and executive director of the Advanced Television Systems Committee, an industry group. "It's all going to depend on how long the testing takes and how many systems are built."

Of the proposals vying for attention, experts say some will not be built, some will not work, and others may ultimately be ruled out because they do not offer compatibility with current NTSC TVs. The rest will be judged on moving- and still-picture quality, the robustness of their transmission signals, cost, and other factors that Hopkins says have yet to be determined.

Many in the electronics industry have worried aloud that a delay will allow the Japanese and Europeans to get an early lead—or even to force a de facto standard on the U. S. Others disagree. If anything, they say, a delay may strengthen any fledgling consortium's effort to establish itself before consumer demand reaches a fever pitch.

As for the specter of other media launching independent drives into HDTV, that's not likely to happen any time soon, says the FCC's Hassinger. "Cable is playing it very cautiously. They carry broadcast programming, and consequently one has to make sure everything fits. They don't want to have to carry different kinds of signals, and there is a question as to whether one could carry different kinds of signals and still have an operating system," he says.

Further, cable-TV operators, though tempted, will not push ahead of their broadcast counterparts, on whom they depend for programming. They are afraid that if they guess wrong, their investment in an incompatible HDTV system would wash away in an instant. As for satellite alternatives, as long as the FCC can set a standard in the next two to three years, most experts don't think there's anything to worry about.

But "if broadcasters have to mess around for another five years, some other media, such as satellites, could come along with a system that is not broadcast-compatible," says James E. Carnes, vice president for consumer electronics and information sciences at the David Sarnoff Research Center in Princeton, N. J. The center, with assistance from NBC and Thomson Consumer Electronics Inc., is one of the proponents hoping to set the standard (see p. 76). *–Tobias Naegele* semiconductor houses are taking a serious interest. Digital Equipment Corp., for example, is doing "a tremendous amount of HDTV-related R&D, in both hardware and software, encompassing video displays, semiconductors, and private and public networks as transmission media," says Bruce Holbein, DEC's manager for government relations in Maynard, Mass. And in Berkeley Heights, N. J., Daniel Lankford, vice president of market development for AT&T Microelectronics, says, "We fully intend to be in the business of providing HDTV chip sets and subsystems. We are beginning to do some work now to define what those chip sets might be."

Another reason for the interest is that as HDTV dawns, consumer television sets are suddenly starting to look a lot more like computers. Some Japanese HDTV receivers already include up to 40 custom integrated circuits, and the typical Japanese TV in the 1990s may contain 1 or 2 Mbytes of video random-access memory.

Future HDTV sets will be able to connect to 100 Mbytes of data storage as well as to printers, facsimile machines, telephones, and a variety of other gear. And they will be two-way interactive, permitting delivery of a variety of services via wide-bandwidth cable or fiber.

"What we're seeing is a coming together of TV and computer technology, and at some point the distance between HDTV and midrange computing really blurs," says Barry Whalen, a vice president at Microelectronics and Computer Technology Corp., the Austin, Texas, research consortium. "That's why we're interested, and that's why Darpa's interested." Whalen "absolutely" sees HDTV as competing against PCs and work stations, and having a big impact on the way computing is sold 10 to 30 years from now.

And computer makers can't afford to overlook the threat, he says. "Every time a technology has changed the way people buy computing, a different set of companies came to the fore." The consortium, in fact, is talking to members about starting a research program next year to focus on what Whalen calls "HDTV in the large." The group would explore ways in which very large HDTV flat-panel displays might one day be used as a kind of "artificial reality"—as a "synthetic window" in the home, for example, or in cockpitlike simulators that consumers might use as a substitute for travel. The concept might also tie into HDTV's built-in processing power and rely on artificial-intelligence techniques for a variety of user-assisted information-gathering and entertainment functions, Whalen says.

Apple Computer Inc., for one, has seen the vision. The Cupertino, Calif., firm recently produced a videotape of how a fictional system it calls the Knowledge Navigator might one day be used in tying computers and HDTV video and graphics together. In the video, a professor interacts with a notebook-sized computer and a large flat-panel HDTV to prepare a lecture in a matter of minutes. The HDTV display is used to show charts, graphics, and maps generated by the computer on demand, and as a videophone when the professor makes calls to other researchers around the world.

'What we're seeing is a coming together of computer and TV technology—the line between them blurs'

"The tremendous interplay between HDTV and computers is already obvious," says James Groell, vice president for special projects at PCO Inc., a Chatsworth, Calif., optoelectronics firm. Some work stations already have near-HDTV quality, and there is no reason to believe it will not be demanded by computer displays of all types when HDTV broadcasting starts in the 1990s, Groell says.

Indeed, the technology will lead to much lower-cost high-resolution screens than those found on today's high-end graphics work stations, say executives at Hewlett-Packard Laboratories in Palo Alto, Calif. HDTV technologies such as displays, memory, and signal-processing chips will drive developments in computers, test equipment and other industrial markets, and military gear, HP says.

Despite the HDTV interest at many big firms, some companies are still holding back. Chip maker Intel Corp. of Santa Clara, Calif., for example, says it has no interest in the business. Likewise Compaq Computer Corp. in Houston. "We're in the mainstream, high-end market," says a Compaq spokesman. "Until any of that [HDTV technology] becomes something where there's higher, broader market demand, the chances are you won't see it from this company."

For those who do hope to participate, most agree on one thing. As Motorola's Mitchell puts it: "The most important question of the day is, 'Which standard?' " Until the FCC decides, the design of HDTV chips and receivers for the U. S. market can't begin in earnest. And in the best-case scenario, U. S. HDTV broadcasting can't begin until 1993.

But some see that time lag as propitious. "The U. S. does have some advantages. This will be our standard. We can set it when we want," says AT&T's Lankford. And by giving the now fractious factions more time to close ranks, it could result in a more measured U. S. plan in any forthcoming manufacturing venture, many believe. "The U. S. has the laboratories for research, the displays, the chips, and the assembly capability," says Groell at PCO. "Technology is not the problem. It's having the will to do it."

Additional reporting by Lawrence Curran, Jonah McLeod, Tobias Naegele, Jack Shandle, and Larry Waller

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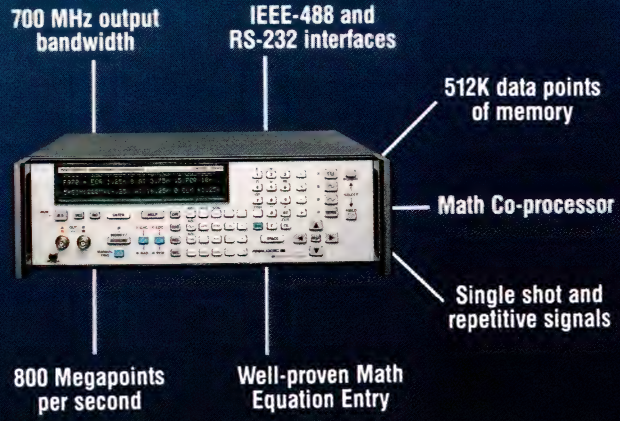
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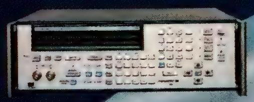
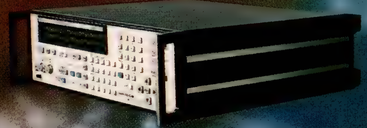
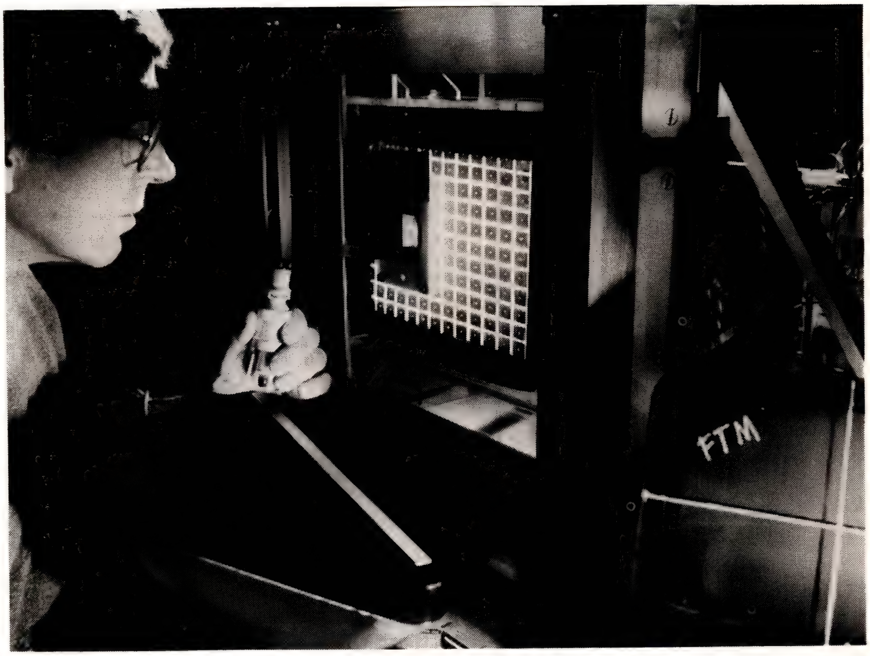




CAN CRTs HOLD THEIR OWN IN THE HDTV ERA?



Zenith's FTM picture tubes could be made in large sizes for HDTV with an unconventional approach based on printing the color phosphors directly onto the faceplate.

The bigger the display, the better the next generation of high-definition TV receivers will look. And the arrival of HDTV is likely to spark the development of high-quality, large-area flat-panel displays, because cathode-ray tubes of the size appropriate for HDTV require very deep cabinets. But Zenith Electronics Corp. is placing its bets on mainstream CRT technology, which it believes will hold sway well into the HDTV revolution.

"I've been in the business for 20 years, and the flat panel is always five years away," says Martin L. Lerner, vice president of engineering at Zenith's CRT Division in Melrose Park, Ill. "The flat panels have yet to become cost-competitive."

Zenith is instead working on a new low-cost way to manufacture its patented flat-tension-mask, or FTM, picture tubes. If the idea pans out, it could help drive down high-volume CRT production costs in the big-screen era, Zenith says. And it could play a role in any drive to bolster U. S. HDTV manufacturing competitiveness. What remains to be seen now is whether the company can attract outside funding to try out the idea. It has already appealed to the Defense Advanced Research Project Agency, and hopes to nab a share of the $30 million the Pentagon has earmarked for HDTV. Zenith also has an entry in the HDTV standard-selection sweepstakes, with its Spectrum Compatible HDTV System one of 20 proposed to the Federal Communications Commission [*Electronics*, November 1988, p. 191].

The Zenith FTM manufacturing scheme relies on an unconventional approach to tube making based on direct printing of color phosphors onto the screen faceplate, instead of the conventional photolithography. The scheme uses high-precision, interchangeable shadow masks that can simply be added to the tube at the end of the production line. Today's methods, by contrast, require the shadow mask to serve as the negative for the faceplate phosphors during photolithography; both the mask and the faceplate must then remain registered for the rest of the production process.

Printing the phosphors directly on the faceplate could be done at low cost using a small machine having very high output, thus eliminating the slow and costly four-step photolithography process, Lerner says. Another advantage is that handling requirements for assemblies moving through the factory would be simplified, since shadow masks could be placed in a clean area until needed.

"We think this could be the nucleus of a very large business" in high-volume, low-cost HDTV tubes, says Zenith chairman and president Jerry Pearlman at the firm's Glenview, Ill., headquarters. The problem is that Zenith, the sole remaining U. S. TV manufacturer, does not have the $70 million to $75 million that Pearlman says it needs to bring FTM manufacturing to high-volume production.

Zenith currently makes a 14-in. version of the FTM using more conventional production techniques. That unit is manufactured for a high-resolution computer monitor. But Zenith has been fishing for funding to develop the technology to produce the big screens for consumer picture tubes. Last year it submitted an unsolicited proposal to Darpa, well before the Pentagon unveiled plans in late December to spend as much as $30 million on HDTV research. Last month, Zenith was reworking its proposal to meet Darpa's requirements for a formal submission. The firm is sure to face competition, but, says Lerner, "we think we're going to win."

> To develop its new technology, Zenith is angling for outside funds

Among other things, he is counting on the appeal of FTM technology, which features a perfectly flat, reflection-free faceplate for superior CRT performance. Compared with conventional displays, the FTM tube provides up to 80% higher brightness, or up to 70% better contrast ratios, at equivalent resolution, Zenith says. While conventional displays rely on a convex glass faceplate and a correspondingly curved shadow mask that is suspended within the tube on springs, the FTM mask is stretched and bonded directly to the faceplate under tension.

As in conventional tubes, the FTM shadow mask is effectively a thin metal sheet containing hundreds of thousands of perforations that help direct beams from the tube's electron gun to the screen faceplate. Here they excite red, blue, and green phosphors to create the video image. But the FTM mask is only one quarter the thickness of conventional curved masks. And since it is stretched tight, it is not subject to movement or expansion due to heating. The result is an inherently more rugged and accurate CRT, Zenith says.

The flatness of the FTM design, in fact, is key to the low-cost manufacturing, because direct printing of faceplate phosphors and using interchangeable masks would be unthinkable with curved masks. "Because this thing is flat, it can be done, though it's not easy," Lerner says. "But it's impossible to do on a curved surface. The tolerances don't allow it." Lerner declines to estimate the savings this might produce. "But enough [manufacturing] steps go away" so that "a very good savings" results. *–Wesley R. Iversen* magnetics—along with the use of higher dielectric-valued materials compatible with CMOS processing. These may make it possible to build megabit SRAMs and DRAMs without the expensive fabrication facilities and complex processing required by conventional techniques.

The jury is still out on which of these technologies will come to dominate the market. All the analysts can do is guess. The EPROM market worldwide will grow from about $1.93 billion this year to about $2.45 billion in 1992, says Mary Olsen, industry analyst at Dataquest Inc. in San Jose. And the market leaders in terms of both units and dollar volume are U. S. manufacturers, she says—AMD, Intel, and Texas Instruments, followed by Fujitsu, Hitachi, Mitsubishi, National, NEC and SGS Thomson.

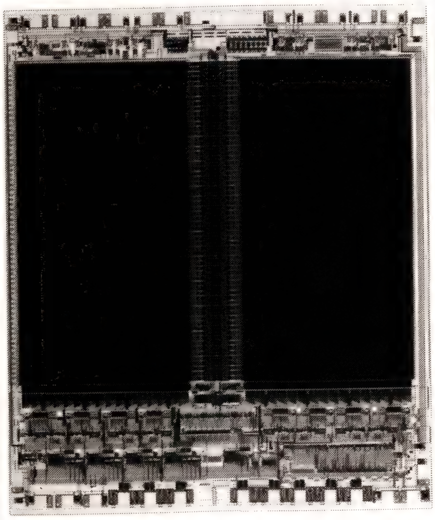
LEADER OF THE PACK. In the move toward higher densities and higher speeds, says Olsen, it is fairly certain that U. S. firms will retain their lead. The same holds true in EEPROMs, a segment Dataquest says will grow from $436 million in 1989 to about $707 million in 1992: here the major players are the U. S. manufacturers Seeq and Xicor at the high-density end. Other U. S. firms—including Atmel, Catalyst, Exar/Exel, General Instrument, International CMOS Technology, National, and SGS Thomson—are competing on a level playing field with Japanese heavyweights such as Fujitsu, Hitachi, Mitsubishi, and NEC.

One big question, says Olsen, is the impact of the new EPROM/EEPROM-based nonvolatile flash memory, which in most implementations combines the hot-electron write feature of EPROMs with the cold-electron floating-gate capability of EEPROMs. One major vendor, Seeq, expects that the technology will grow from virtually no market in 1987 to about 37% of the EPROM market in 1990, and to about 62% by 1992.

The initial applications will be as a replacement for such devices in embedded-control applications, says Sanjeev Dua, marketing manager for flash memory at National. But by the mid-1990s, he believes that most of the market for flash will be in totally new applications, such as SRAM and bubble-memory replacement and as solid-state alternatives to disk drives. By 1992, the cost of flash memory relative to EPROMs will drop to no more than twofold, versus the present 400%-to-500% differential. Relative to EEPROMs, says Niles Kynett, project manager for flash memory at Intel, it will drop from about 60% to about 20%.

In programmable logic, which Dataquest expects to grow from about $275 million in 1989 to about $700 million in 1992, virtually all of the major players remain U. S. manufacturers. The much smaller, but faster-growing CMOS portion, which presently constitutes 30% of the total market, is expected to grow to about 45% by 1992, up from only a 16% share in 1987. Even here the major players remain U. S.-owned. They include Cypress (28%), Altera (20%), Lattice (13%), Intel (11%), and AMD/MMI (8%). Noticeably absent is any major Japanese presence except for Fujitsu and Ricoh, and one lone Korean firm, Samsung.

A key element in CMOS PLDs and programmable gate arrays gaining market share is their ability to more than match conventional gate arrays in density and cost per bit, on the one hand, and the speed of bipolar small-scale-integration and medium-scale-integration standard logic and PLDs, on the other. At the high-density end, for example, AMD, a second source for the SRAM-based Xilinx logic-cell arrays, has just introduced a new generation of circuits that use a 0.8-μm CMOS process to achieve a gate toggle rate of 100 MHz.



Intel is ready with a 1-Mbit flash EEPROM featuring 90-ns read-access times.

At Altera Corp. in Santa Clara, a 0.8-μm CMOS process is being used to achieve gate densities as high as 6,000 equivalent gates in its multiple-array-matrix family. The parts also have propagation delays of no more than 30 ns, allowing their use in systems with clock speeds of up to 50 MHz.

Intel has developed a new addition to its microcomputer programmable-logic circuits that combines a 1.0-μm CMOS process and circuit innovations to achieve a 6-ns delay time in a proprietary PLD with 16 inputs and eight latched outputs, equal to the best that TTL PLDs of comparable size are able to achieve. A key circuit innovation is a distributed TTL translator that is integrated into a symmetrical latch that turns off output drivers much more quickly. At 100 MHz, active power is only 125 mW, at least 25% lower than bipolar implementations.

In electrically erasable PLDs, vendors are similarly pushing for as much speed as possible. In its family of generic array-logic devices, Lattice Semiconductor Corp., of Hillsboro, Ore., is continuing to push the performance further down into the bipolar arena. With its latest 0.8-μm CMOS process, Ultramos III, it has driven propagation delay times down to as low as 10 to 12 ns in its 300-gate-equivalent GAL20V8, and to about 15 ns in its 500-gate-equivalent GAL22V10. In its 700-gate GAL6001 generic programmable-logic arrays, the company expects Ultramos III to achieve propagation delays of 20 to 25 ns.

Going for both speed and gate-array-like densities in EEPLDs, International CMOS Technology Inc. of San Jose is applying both process and architectural improvements to a new family of devices that allow densities as high as 3,000 equivalent gates and gate delays as low as 25 ns (see p. 86).

There is still a considerable market for medium- to low-speed EPROMs in the 150- to 200-ns range for low-end 4-, 8-, and 16-bit microcontroller applications as one-time programmable replacements for mask-programmable ROMs. But the fastest-growing portion of the market is the one serving the needs of the new generation of 20- to 30-MHz complex- and reduced-instruction-set microprocessors.

To store large amounts of application microcode, protocol-conversion data, or type fonts in such applications now requires a designer to choose among high-speed SRAM, with its lack of nonvolatility, or battery backup. Traditionally, such applications have been served by bipolar PROMs. However, because of power-consumption requirements, they are limited to densities below 128 Kbits.

Except for niche applications requiring speeds below 10 ns, most bipolar sockets for devices up to 128 Kbits are rapidly being replaced by lower-power CMOS alternatives. CMOS EPROMs are starting to replace bipolar devices at the 16-, 64-, 128-, and 256-Kbit levels for applications requiring access times of 25 to 45 ns; the CMOS parts run at similar speeds but use half to a quarter the power.

The speed battle will no doubt expand to the higher densities. Companies such as AMD, Intel, and WaferScale are now producing 1-Mbit designs in the 90-ns range. On the way from WaferScale Integration Inc. in Fremont, Calif., are 1-Mbit EPROMs, based on a proprietary staggered-contact architecture and using a 1.25-μm CMOS process capable of speeds ranging from 60 to 90 ns. Also in the works is a 4-Mbit design that builds on the earlier technology by using a staggered-gate scheme to achieve die areas that are no larger than competitive devices in development at Intel, NEC, and Toshiba, but at 90 to 100 ns are 50% faster (see p. 84).

WaferScale Integration is also plan-programmable gain equalizer and a programmable loop-back controller.

In the longer term, U. S. companies are hard at work on radically new nonvolatile technologies. Antifuse technologies, such as the competing versions being developed by Actel Corp. and Integrated Circuit Corp., are one. Ferroelectric memories, under development at Krysalis Corp. and Ramtron Corp., are another.

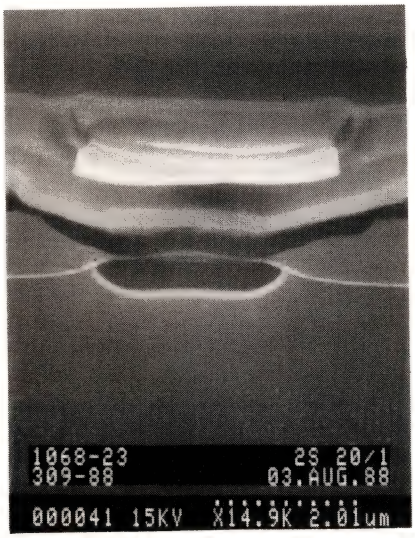
Where existing fusible-link bipolar devices are programmed by blowing links, antifuse devices are programmed by establishing interconnections. The two antifuse companies are taking different routes to commercializing their technology. Actel of Sunnyvale, Calif., has chosen to develop a family of user-configurable, one-time-programmable gate arrays, which in the initial implementation will allow densities up to 6,000 gates. ICC, by contrast, is using high-speed nonvolatile memories as the initial route to commercialization (see p. 87).

Despite competing technologies and product strategies, however, both companies agree on one thing: the long-term potential of antifuse technology. Not only is the antifuse extremely scalable and compatible with existing high-density VLSI CMOS processes, but the number of contacts for an equivalently sized chip is twice that of a gate array, says John McCollum, the manager of technology development at Actel.

The scalability of the antifuse devices opens up a wide range of possibilities beyond gate arrays and nonvolatile memory, says Bruce Roesner, president of ICC in San Diego. Antifuse technology will also be important in cell-based custom and semicustom designs, where antifuse-based PLAs could be used to implement random logic and antifuse-based ROMs and PROMs on the same chip for program storage. Incorporated into microprocessors, he says, antifuse-based ROM microcode can be changed either by field programming or by changing the last mask to alter the microcode. "In RISC-based designs, for example, it should be possible to incorporate more RISC instructions in the form of table-lookup or PLA implementations," Roesner says.

Another coming technology, ferroelectric memory, will have a fundamental impact on two levels, says Howard Bogert, executive vice president of Dataquest. One is as a nonvolatile memory with write/programming speed equivalent to that of SRAMs, he says. The other is by taking advantage of their higher dielectric constant to eliminate the need for advanced trenching techniques now required in high-density DRAMs. "With the cost of building a DRAM production line approaching half a billion dollars, something in the way of a revolution is needed," he says. "Ferroelectric RAM technology could be it."

Ramtron Corp. of Colorado Springs, Colo., has already formed alliances with several companies to commercialize its process. Among them are ITT Microelectronics, NMB Semiconductor, and TRW. In the first phase of its ITT agreement, Ramtron transferred its existing 3.0-μm ferroelectric technology to ITT. In phase two, which has already begun, the ferroelectric technology is being moved to ITT's existing 1.5-μm CMOS process, with plans for a linear shrink, which will take the process to 1.2-μm. For the 1.5- and 1.2-μm technology, the ferroelectric technique will still be an additive process. In this approach, the size of the ferroelectric cell will be 1.5 by 1.5 or 1.2 by 1.2 μm. That will be sufficient to build devices of up to 256-Kbit density, according to Richard Horton, Ramtron's president.



Actel uses antifuse technology in one-time-programmable gate arrays.

In phase 3, Ramtron and ITT will codevelop an entirely new 0.8-μm process. In this process, the ferroelectric technology will no longer be additive, but will be merged with the CMOS double-level-metal process to produce a 0.8-by-0.8-μm ferroelectric cell, with the necessary density for building ferroelectric RAMs up to 4-Mbit densities, Horton says.

In terms of upcoming products, Horton says the firm intends to attack three separate markets with what he calls low-density, medium-density, and high-density product families.

The low-density family, to be built in the 1.5- and 1.2-μm technologies, will include five parts, at densities of 256 bits, 512 bits, 1 Kbit, 2 Kbits, and 4 Kbits. These parts will be announced and provided in sample form during the second half of this year. They will be aimed at applications now served by nonvolatile RAMs and small EEPROMs, including radio-frequency identification tags, smart cards, electronic odometers, and utility meters. The medium-density family will consist of three parts, at 16, 64, and 256 Kbits, with the same pinouts as current EEPROM devices. The high-density family will use the 0.8-μm technology and will consist of two products: a 1-Mbit part and a 4-Mbit part.

Horton, naturally, believes that ferroelectric technology holds the potential to shake up memory markets. But he is quick to note that, in the near term, "we are not targeting mass- or broad-scale displacement of DRAMs or disk memory on a cost-per-bit basis."

RUGGED. Rather, Ramtron will aim initially for areas where very rugged nonvolatile memories are required, in which size, weight, and reliability are the critical parameters. For example, the high-density 1- and 4-Mbit parts will sell for up to twice the price of DRAMs on a per-bit basis when they go into production in 1992 or 1993. "And our forecast says they will converge on DRAMs in price per bit by the mid-1990s," Horton says.

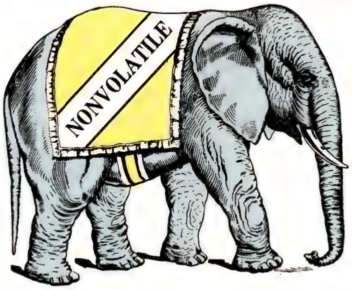
Krysalis Corp. of Santa Clara is planning a family of nonvolatile latches and registers that will be 74-TTL-series-compatible, says vice president of technology William Miller. The first one, due for sampling in September, is the 74CF374, which will be an octal-D flip-flop. The part will have the same pinout as a TTL part, but it will be capable of holding the output states in a nonvolatile shadow memory.

Krysalis is also looking at a market for parts that could be a direct replacement for battery-backed nonvolatile SRAMs and EEPROM-based nonvolatile RAMs. Instead of SRAM shadowed by EEPROM, the Krysalis devices will write directly to a ferroelectric cell. These parts, which may be in production by early next year, will be able to do the same job that nonvolatile RAMs do but at lower power, lower price, and with better features, according to Miller.

"Once we get down the learning curve in this technology," Miller says, "it certainly has the potential of providing an economical, high-density, nonvolatile random-access memory. The simplicity of having the ability to use a single memory type and having all your memory in your nonvolatile system brings you back to the architectures that people were using in the 1960s, when they were using magnetic core." The difference, he says, is that "we'll have the capability and economics of solid-state memory."

How fast will that happen? At this point, no one can say, but Miller points out that after MOS memory became widely available some time in the late 1960s, it pretty well wiped out core memory in less than 10 years. "Revolutions in this industry can take place fairly quickly," he says. "Ten years from now, most people probably won't be able to remember when most of the memory in a system wasn't ferroelectric." ☐

SEEQ PUSHES FLASH MEMORY TO 1 MEGABIT



On the fast track toward higher densities, Seeq Technology Inc. is coming to market with not one, but two 1-Mbit nonvolatile flash-memory products. The devices are built using a 1.5-μm n-well CMOS version of the n-channel MOS process the San Jose, Calif., company used to make its first flash device in mid-1986—but the products represent an eightfold increase in density.

The new parts are both 128K-by-8-bit devices, compared with their 16-K-by-8-bit predecessors [*Electronics,* Aug. 21, 1986, p. 53]. The 48F010 targets applications using electrically erasable programmable read-only memory; the 27F010, EPROM applications. The increase in density they both achieve outstrips the growth rate of both full-featured EEPROMs and ultraviolet-erasable PROMs, says Mike Villott, marketing manager for the company's electrically erasable memory division. More than that, he says, it outdoes the growth rate of any other memory technology as well. He predicts that flash memory devices will track the density of EPROMs and eventually bypass them by the mid-1990s.

What makes the fast track to high density possible is the fact that flash nonvolatile memory draws on the features of two other well-characterized and mature nonvolatile technologies. Seeq and the others working with the technology, such as Intel, National Semiconductor, and Toshiba, combine the hot-electron-injection-based write mechanism of EPROMs with the electrical erasure by cold-electron-tunneling used in conventional full-featured EEPROMs.

What makes Seeq's approach different in its 1-Mbit flash devices is the company's one-and-a-half transistor design. It combines the EPROM transistor and a read-select transistor into a single 5.6-by-4.4-μm cell. As flash devices, either the entire array or extensive subsections are erased simultaneously. By contrast, most full-featured EEPROMs have two transistors and can be erased and reprogrammed byte by byte.

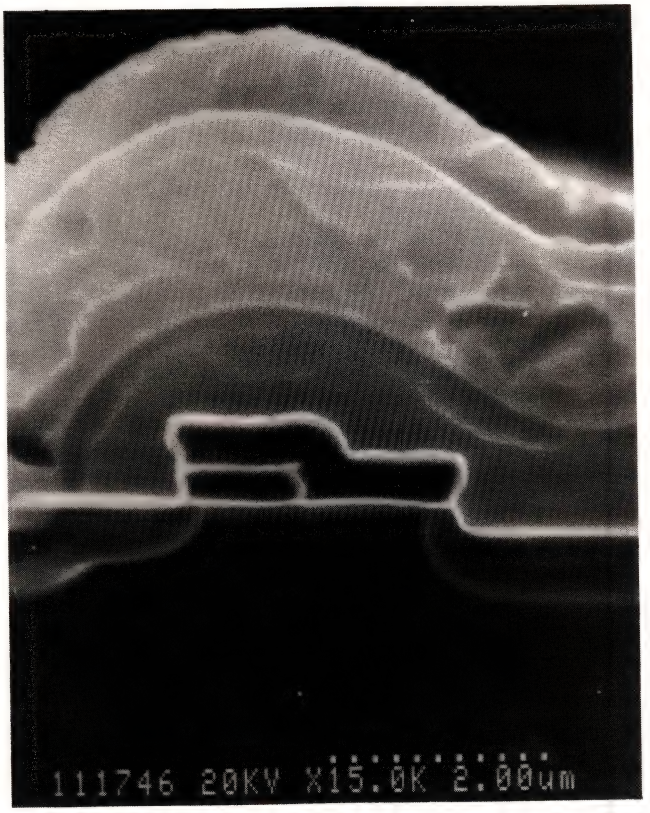
A number of companies have developed their own single-transistor designs. But Seeq modifies the basic EPROM cell so that the polysilicon gate controlling the channel between it and the floating gate extends beyond the edge of the floating gate. This creates a phantom select transistor (at the rightmost end of the gate structure in the photo, where it overlaps the diffusion), thus eliminating the need for a separate external transistor.

This solves a problem created by other approaches to flash-memory design, Villott says. In most designs, the cell's floating gate is, in the erased state, depleted of electrons, and it therefore behaves like a depletion-mode transistor. That makes the device overshoot or undershoot its threshold limits, so that an unaddressed cell in the erased state leaks current. This leakage causes false data reads or failure to program.

In the Seeq approach, both the drain and source sides of the cell are self-aligned. The section of the channel under the influence of the phantom control gate forms an n-channel select transistor. This transistor operates in the enhancement mode. Linked to the floating gate in series, the enhancement-mode transistor cancels out the effect of the depletion-mode transistor, preventing leakage.

Programming in the one-and-a-half-transistor cell is similar to that in an EPROM, using hot-electron injection in the channel between the control gate and the floating gate. During programming, the phantom select transistor is on only in the addressed cell. The phantoms in all unaddressed cells are off.

Erasure uses Fowler-Nordheim cold-electron tunneling from the gate to drain diffusion. During the process the control gate is grounded and the drain raised to high voltage.



In Seeq's design, a control gate overlapping the floating gate creates a phantom select transistor, so no external transistor is needed.

The two devices differ in operating range and programming flexibility. The EEPROM version can be erased and programmed over a temperature range of 0 to 70°C; it offers endurance up to 1,000 program and erase cycles. The EPROM can be erased and reprogrammed only at room temperature; endurance is 100 cycles.

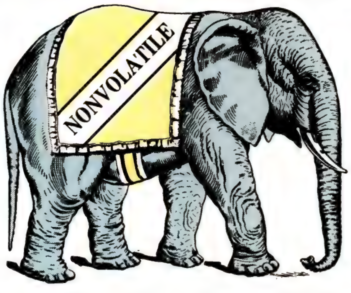
Both parts are available in the same Jedec-standard, byte-wide, 32-lead pinout. And both feature a bulk-erase time of less than 5 s for the entire array. Typical read-cycle time is 200 to 300 ns. A sector-erase capability allows individual erasure and reprogramming of 128 sectors of 1 Kbyte apiece. Sector-erase time is 500 ms, while write-cycle time is 100 to 150 μs/byte. An externally generated 12-V signal does the programming; an internally generated 12-V signal erases.

In flash-erase mode, the external signal powers internal pumps that supply the drain current of the cells to be erased. During the erase, the floating gate becomes less negatively charged through Fowler-Nordheim tunneling. The gate of the cell remains grounded.

Programming is similar to programming an EPROM. At powerup, a special circuit protects the memory against false write and erase. A 10-MHz oscillator drives a three-loop sequence of 30 shift-register generators, which provide the waveforms needed for programming and flash operations.

Available this month, the 48F010 flash EEPROM in plastic dual-in-line packages is priced at $92, in quantities of 100. The 27F010 flash EPROM is priced at $78.75 in similar quantities. *–Bernard C. Cole*

ICC TAKES THE ANTIFUSE ONE STEP FURTHER



Before the end of the year, a new player in the user-programmable logic and memory market will be arriving on the scene with a highly promising technology. Instant Circuit Corp. of San Diego, Calif., has developed an innovative antifuse-based technique that is compatible with all types of processes: CMOS, bipolar, and gallium arsenide. Company founder Bruce Roesner believes the approach will pave the way for a new generation of speedy, high-density VLSI-level memories, logic chips, and gate arrays.

In embracing the antifuse concept, the ICC parts are kin to the programmable gate arrays from Actel Corp. of Sunnyvale, Calif. [*Electronics*, Feb. 18, 1988, p. 75]. An antifuse approach means implementing functions by establishing interconnections at predetermined locations. By contrast, the current crop of bipolar fuse-based technologies, including programmable read-only memories and logic devices, gets programmability by blowing connections between gates to configure a function.

But, says Roesner, ICC's antifuse technology, for which at least half a dozen patents have been issued, differs radically from Actel's. Actel relies on a proprietary dielectric placed between an n^+ diffusion and polysilicon layer in any CMOS, biCMOS, or bipolar process. ICC, on the other hand, builds its antifuse structure atop a preexisting substrate and subsequent layers of logic and/or memory. Except for specific contact points, these two layers are separated by an oxide layer in an architecture much like that used in silicon-on-oxide insulator techniques.

ENHANCES SPEED. That's why ICC's programming methodology can be applied to all forms of ICs, Roesner says. A programming voltage compatible with today's memory chips (5 to 20 V) can be selected by controlling the thickness of the deposited programming layer. For example, he says, 10 V applied for less than 20 ns across the instant-circuit element results in a permanent connection with a resistance of only a few ohms. Thanks to the low capacitance of the instant-circuit memory bits and diodes, speed is enhanced no matter which semiconductor technology is used for the base circuitry. "This is especially true as the memory or logic array size gets larger," he says.

When programmed, the memory element is essentially a diode in series with a short circuit. When unprogrammed, it acts as an insulator. As a result, he says, the diode and interconnect structures are less affected by radiation than are active semiconductor transistor and diode structures. Roesner says test devices have remained operational even when subjected to as much as 5 Mrads, full dosage.

One indicator of the performance improvements possible with the ICC approach is the first product the company is developing, an 8-K-by-8-bit, two-level-metal CMOS field-programmable ROM. The device, to be introduced before the end of the year, is fabricated using conservative 2.0-μm design rules and has a target access time of 35 ns. That's comparable in speed to similar EPROM-based devices fabricated with 1.2- to 1.5-μm design rules. The programming rate is 30 ns/byte. Active power dissipation is 140 mW and standby power is 110 μW. Roesner says initial devices will closely approximate the performance specs of existing parts, even though the technology allows parts that are even faster.

The technique is compatible with all IC processes: CMOS, bipolar, and GaAs

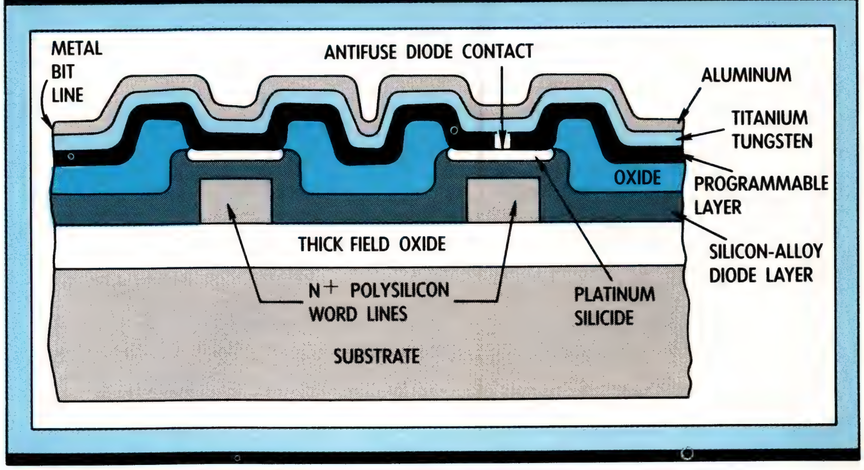
In these one-time programmable PROMs, the logic for address-decode and other peripheral support logic is built on a standard substrate using existing CMOS technology. The same holds for an array of field-effect-transistor elements. Onto this substrate is placed an insulating oxide layer, upon which the programmable antifuse structure is built. In a ROM, this involves selective deposition of a platinum-silicide layer over each transistor element, followed by another oxide isolation layer, which is masked out above the transistor elements. Then the antifuse programming layer is deposited, followed by barrier metal, such as titanium tungsten. At the end comes a conductive aluminum layer.

The result is a cross-hatched array of polysilicon and multilayered-metal lines. Information in a particular cell is programmed by cutting through the proprietary programming layer, forming a selectable contact in the form of a Schottky diode at the crossing of the two above each FET element. Then, depending on whether positive or negative logic is used, the presence of a contact indicates either a logical 1 or a logical 0; the absence of a contact indicates the opposite.

Each polysilicon line consists of n^- material in direct contact with the n^+ layer. In the multilayer metal lines, the aluminum reduces the lines' resistance and the barrier metal prevents the aluminum from diffusing through the polysilicon lines. The junction between the programming material, the barrier metal, and the n^- FET element forms the Schottky diode. Tests have shown the diodes to have a turn-on voltage less than ½ V, a leakage current of only 15 nA, and a reverse voltage breakdown of 10 V. To implement such a structure to form a programmable logic device requires only a minor modification of the top layer of interconnect lines.

–Bernard C. Cole

HOW ICC BUILDS ITS ANTIFUSE STRUCTURE



Instant Circuit Corp. builds its antifuse structure atop a preexisting substrate and layers of logic and/or memory with an oxide layer in between, in a scheme reminiscent of silicon-on-oxide.

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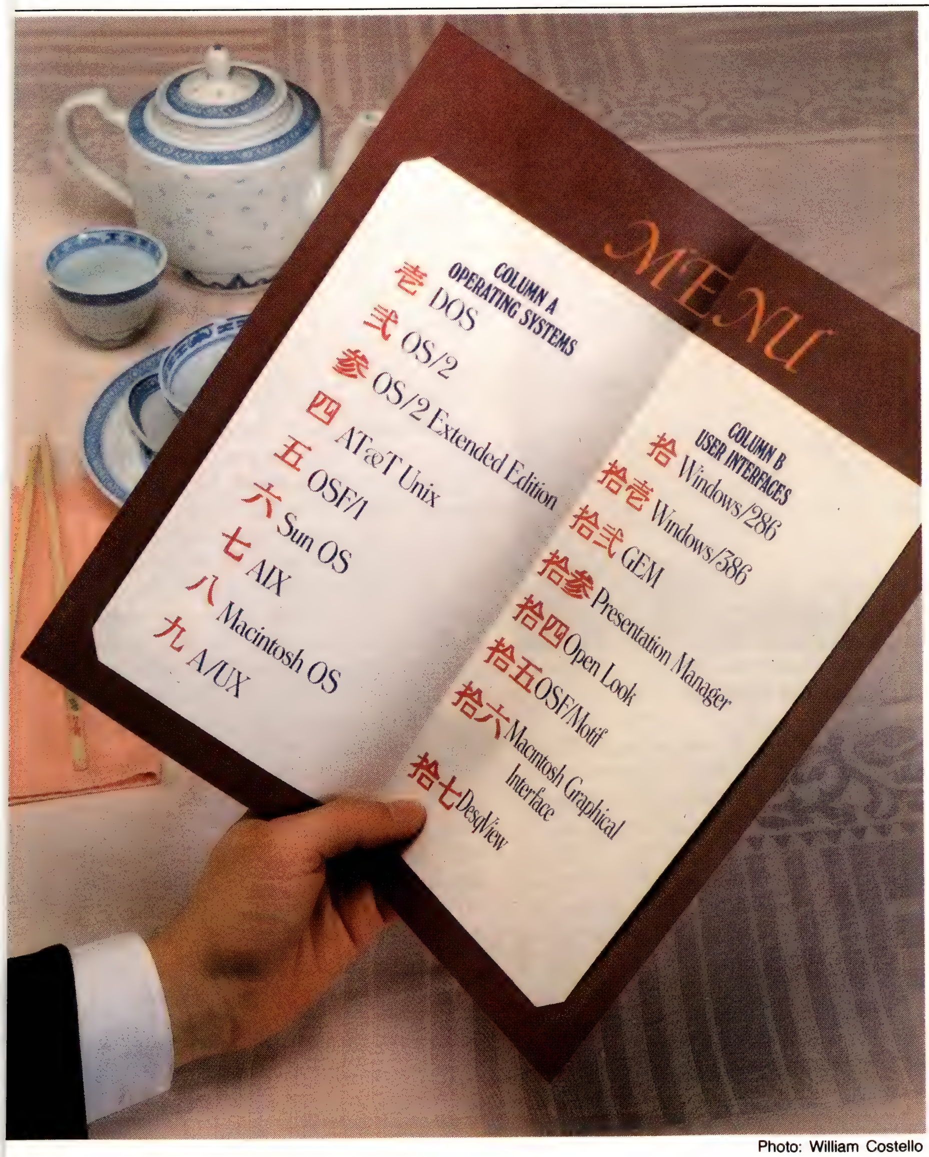


Photo: William Costello

Which is the best upgrade path from DOS? What will it cost? When is the time?

but when, to change over," he says. "But is it a smooth transition to graphical user interfaces? to departmental computing? to local-area networks? No."

Naturally enough, the software houses believe that any transitional pains are just part of the process. "There are different products to meet different user needs," says Mark Mackaman, OS/2 product marketing manager at Microsoft Corp. in Redmond, Wash. "Users should identify their needs, then find out what applications satisfy these needs. The applications will dictate the operating system, which will dictate the hardware platform required." It will take some hard work to sort all this out, he says, but the result will be more productive computing.

One of the more beguiling possibilities raised by the turmoil in PC software is the chance it offers for Unix to break into the mainstream. Currently there's a flurry of activity to provide PC applications in Unix and to make available mixed environments where Unix and DOS applications both run. Unix is available in several flavors now for the more powerful high-end machines built with the 80386 processor. It offers a multitasking, multiuser environment that makes full use of the architecture's 32-bit capabilities, well beyond what OS/2 can do. Soon there will be a couple more versions of Unix that could drive both 386 and future 486-based machines—AT&T and Sun Microsystems Inc.'s merged Unix System V.4 and the Open Software Foundation's OSF/1.

While some observers see Unix overtaking OS/2 in the high-performance segment of the industry, others believe it will remain enmeshed in the niche market areas it now serves. "Unix tends to be sold in niche marketplaces and as a platform for building vertical applications," says Microsoft's Mackaman. About 65% of the Xenix applications sold (Microsoft's earlier version of Unix) have been used in this way, he says. "I see Unix systems [in the future] as a server in the OS/2 and LAN Manager environment," says Mackaman. The LAN Manager is a networking program developed by Microsoft and 3Com Corp. of Santa Clara, Calif., that ties PCs running DOS and OS/2 in the same network. Microsoft is offering a variation, called LMX, for Unix; it brings computers running Unix into the same networks with OS/2 and DOS machines.

JUST ONE. LMX is just one of many developments that are giving Unix a better chance at penetrating the PC world. Sun last year introduced its 386i computer running the Sun OS version of Unix. The machine, which falls in the high-end-PC price range, boasts a graphical user interface called Sun View, built-in networking capability, and the ability to simultaneously run MS-DOS applications: multiple DOS applications can run in Sun View windows at the same time that Unix applications are running in other windows. To accomplish this, Sun uses the VP/ix product from Phoenix Technologies Ltd., Norwood, Mass., which implements the DOS windows and largely performs the DOS-Unix integration.

Besides allowing the applications to transfer data among themselves, the Sun system also supports interprocess communications between Unix and DOS. This is done through a product called PCNFS, a PC extension to Sun's Network File System, which the Mountain View, Calif., company released last December.

"Someone on a DOS machine today who is stretching the limitations of DOS has two choices in a step to the future: he could move up to Unix or OS/2," says Will Poole, senior software product marketing manager at Sun's East Coast division in Billerica, Mass. A Unix machine is a viable choice for breaking free of DOS's limits, he says, because it delivers a large address space, a graphical user interface, a good software-development environment, and a bunch of technical applications. These goodies come at no loss of investment in DOS applications and training when a DOS-under-Unix product is also used.

It's not surprising, then, that more and

2 Extended Edition or Unix, and a graphical user-interface system.

To justify and fully exploit work-group computing systems, new applications that effectively use the richness of the operating environment must be available. But currently, such applications are few and far between. Still, companies can start now to buy and install the hardware, networks, and operating software for work-group computing and be ready when the applications arrive. The cost will be considerably higher than running a bunch of stand-alone PCs, but the eventual payoff appears certain. The most computer-savvy organizations can start to build some of their own applications for this new environment and then add off-the-shelf packages as they emerge.

On the other hand, the independent software vendors' task is to bet on which mix of operating systems and user interfaces will survive—and thrive. Then they must decide how to offer their applications for as many of the popular platforms as possible. System vendors offering only hardware have the easiest decision—just make sure that their hardware can run all the major operating-software environments.

The blossoming of PC networks as a productivity tool in large corporations has generated its own rubric: work-group computing. PC networks, central servers for files, communications, printers, data bases, and access to corporate data on mainframes and minicomputers are emerging as the tools of this segment. "During the last six years of personal computer evolution from the 8086 to the 20-MHz 386, most users were after personal productivity [enhancement]," says Compaq Computer's Stimac. "But as we move into the 1990s, we see PC software evolving to work-group productivity."

Work-group computing justifies the added cost of OS/2 or Unix

–SYSTEM CHOICE

OS/2	Unix
One	Many (depending on system performance)
80286 processor, 6-to-8-Mbyte memory, 20-Mbyte hard disk	68020 or 80386, 4-to-8-Mbyte memory, 40-to-80-Mbyte disk
16 Mbytes per process	3 Gbytes per process
Virtual, demand-segment swapped	Virtual, demand-paged
Protected-mode operation at operating-system level	User passwords, group-level permission (Orange Book Class C1 level)
16-bit protected	16- and 32-bit protected
Thread within process	Process
Shared memory, message queues, semaphores, pipes	Shared memory, message queues, semaphores, pipes
Interrupt-driven	Interrupt-driven
LAN Manager	TCP/IP, NFS, RFS

Networking demands using the newer operating software technologies to handle sophisticated data-base applications on groups of desktop work stations. "It certainly seems clear that it's a strong trend," says David Liddle, chairman and founder of Metaphor Computer Systems Inc. of Mountain View. "A few years ago, networking was thought of as exotic; not now, when most desktop computers in the Fortune 500 [companies] come in ready for networking and get connected right away," he says.

Metaphor has been supplying its distributed-network computing system, called the Metaphor Data Interpretation System, to a growing number of Fortune 500 company customers since 1985 on its proprietary work stations and servers. Last year it completed an agreement with IBM for porting the DIS software to the IBM PS/2 under OS/2 Extended edition and opening the door for other technology transfers between the two companies.

Distributed data-base computing will spur new growth in the PC segment when it gets rolling at top speed. "There is a big rise in the number of companies thinking about and starting to implement a whole new suite of applications with more value" than the traditional single-user PC applications like spreadsheets and word processing, says Liddle. "All of these require access to lots of data from a wide range of sources."

Whatever combination of hardware, operating system, user interfaces, and networking users select for the new world of distributed applications, it will not come cheaply. The PC or work-station platforms required to run the newest applications will initially be three to five times as costly as the typical single-user stand-alone personal computer in use today—an AT-type DOS machine or the original Macintosh, for example. And on top of the work-station costs, networking and servers must be added.

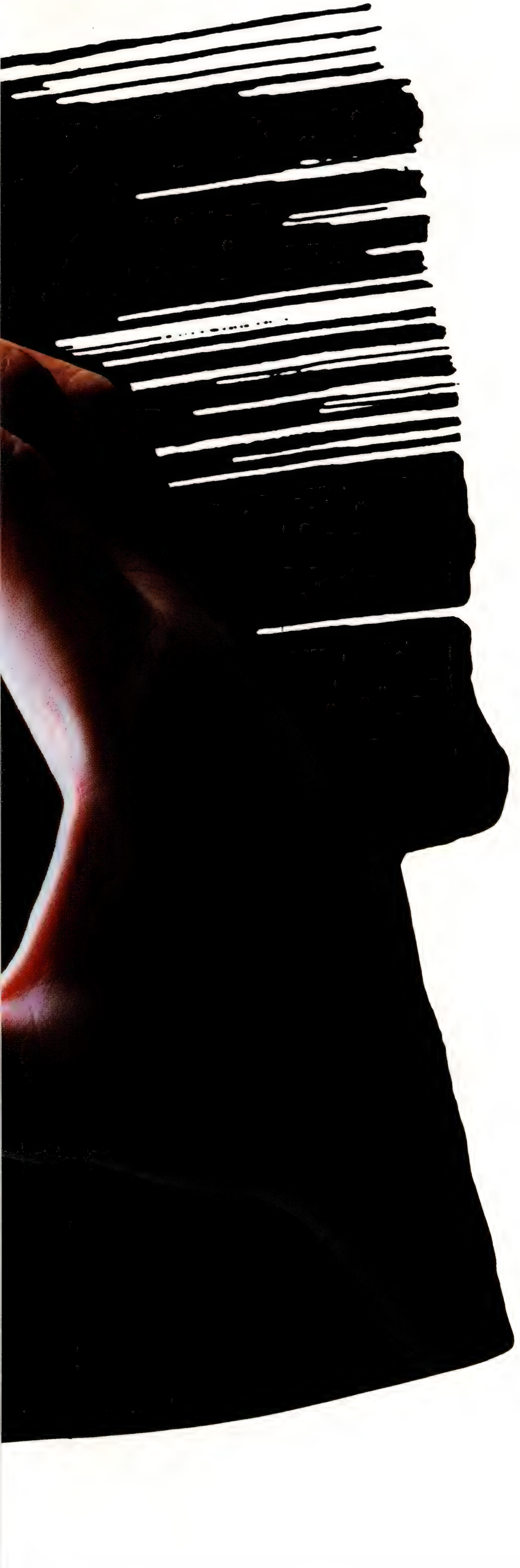
To run multitasking operating systems, networking, and data-base managers requires processors like the Intel 386 or forthcoming 486, the Motorola 68030 or future 68040, or even some of the new RISC processors. Memory capacity of several megabytes and up to 10 Mbytes or more is also needed, since graphical user interfaces, such as the Presentation Manager, soak up several megabytes of main memory to run efficiently. The applications that will take advantage of these systems will require plenty of disk storage, either on the work stations or at data servers. This level of hardware and software can easily run from $10,000 to $25,000 per user at today's prices.

Each of the advanced operating systems has available one or more graphics-oriented user-interface environments designed to run with it. They are all slightly different. OS/2 users have the Presentation Manager, and DOS users can choose from a couple of versions of Microsoft Windows and other packages, such as the Digital Research GEM system. And there are a number of user environments for Unix. Besides Sun View, AT&T and Sun are building a user interface called Open Look to go with their new merged Unix, System V.4. Then there's the Open Software Foundation's OSF/Motif, a user interface made up of several pieces of other interfaces, with the behavior and look of the Presentation Manager.

"As you look at the different operating environments moving through the PC market, there is one common thread—most users want windows," says Compaq's Stimac. The various graphics-oriented user interfaces and operating systems are all designed to make personal computing more effective, more efficient, and easier to do. But a price must be paid for this. First, a much more expensive computer configuration is required, and second, while easy to use, the new system may be rather complex to set up and support. Either an information-system staff or manager may be needed.

ABANDON DOS. Meanwhile, one of the most important choices facing PC users is whether to abandon DOS for new technology—OS/2 or Unix and a graphical user interface—and if so, when. Of course, there is little need to make this wrenching and costly shift if DOS is still doing the job. Users have a huge investment in equipment, applications, and training—more than $100 billion—in the original industry-standard IBM PC. For companies making the changeover, much of this massive investment will have to be written off.

Still, a lot of today's installed equipment base is probably about ready to be replaced anyway, and this presents an opportunity for users who will be buying high-power hardware to take advantage of the newer software. But for other users, the feeling might be, "if it ain't broke, don't fix it." Much can be said for this approach. For many, DOS is going to be around for a long time—another five years at least. ☐



Sizing Up the Earth in 200 B.C.

Eratosthenes believed the earth was round. As director of the great library at Alexandria in Egypt, he decided to go beyond abstract argument and actually measure it to back up the argument.

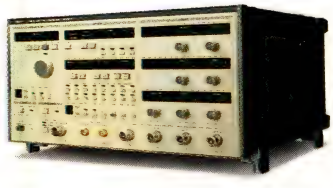
Eratosthenes

Knowing that the midsummer noon sun shone straight down a vertical well in Syene far to the south, he measured the slight angle of the sun's shadow in Alexandria on the same day. He figured the distance between the two cities by how long it took a camel to walk there. Then, with a little simple geometry, Eratosthenes came up with fairly accurate figures for the earth's circumference and radius. His pioneering measurement made a significant impact on history.

Communications Support for 2000 A.D.

Today, Anritsu's pioneering efforts in communications measurement are also paying off. Anritsu has long been a leader in the most sophisticated measuring methods, and continues to reach new levels of accuracy. The complex technologies behind modern multiplex techniques, for example, demand the highest degrees of precision. That's why carriers and manufacturers alike turn to Anritsu for the answers when it comes to accurate measuring and test equipment for communications.

Anritsu continues the pioneering tradition in measurement.



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Circle 55

drives was the massive commitment by IBM in 1987 to manufacture drives in the 3.5-in. form at its plant in Fujisawa, Japan. The 3.5-in. drive pervades the PCs from Apple, Compaq, and IBM.

The capacities of these small drives is headed up fast. According to Devin, IBM is working on a 380-Mbyte 3.5-in. drive that industry watchers say will take the market by storm. Though not yet announced, it is part of the 3.5-in. family that began with a 120-Mbyte drive using thin-film media. Other firms are not far behind. Conner Peripherals Inc. of San Jose was just one of the players announcing 3.5-in. drives in the 200-Mbyte range at the Comdex show in Las Vegas last November.

Nor are PCs the only market. At capacities over 100 Mbytes, 3.5-in. drives are displacing 5.25-in. drives in work stations. Digital Equipment Corp., for example, announced in January that it is using a 100-Mbyte 3.5-in. unit from Conner Peripherals in the new DECstation 3100. "The 100-Mbyte 3.5-in. drives are now replacing 85-Mbyte 5.25-in. full-height and half-height drives in the work station, and the promise is that these same work stations will be offering 200-Mbyte 3.5-in. drives by next year," says Scott Holt, vice president of marketing and sales at Conner.

But the 5.25-in. drive is not going to go down without a fight. "You must remember that there are a lot of half-height 5.25-in. slots in the market and they can be filled with either 3.5-in. or half-height 5.25-in. drives," says Porter. "A Compaq desktop system, for example, has two full-height slots."

In the Compaq system, a 180-Mbyte 5.25-in. half-height drive could easily have been used in place of the standard 3.5-in. product. Indeed, half-height drives offer the user the attraction of slightly higher capacity and performance. A 14-ms average access time has been quoted for 5.25-in. drives, whereas the 3.5-in. units can currently offer 25 ms at best.

Manufacturers of 5.25-in. drives are moving into still higher-capacity ranges. One product to bow this year is a 380-Mbyte half-height 5.25-in. drive. "Micropolis, Imprimus, and Newbury Data are all readying products," says Porter. Maxtor has also said it will have a 380-Mbyte 5.25-in. unit when others start to ship.

Drive makers with 380-Mbyte full-height offerings are already shipping 760-Mbyte drives. Manufacturers who entered the 380-Mbyte arena late, such as Miniscribe Corp. of Longmont, Colo., are leapfrogging the 380-Mbyte level and building a 760-Mbyte product to get a piece of this market as it takes off. Others are going even further. "IBM is currently buying most of the production of 760-Mbyte disk drives from Maxtor," says Devin, "because the giant is concentrating on building a 1.2-gigabyte 5.25-in. drive." □

. . . AND TAPE DRIVES MEET THE CHALLENGE

Aesop's fable of the tortoise and the hare illustrates well the relationship between disk and tape development: tape-drive technology is like the slow-but-sure tortoise, moving forward deliberately but always catching up in the end with the disk-drive jackrabbit.

As Winchester-drive makers reel from the glut in their market, tape-drive manufacturers have just about caught up again. Technology developed for consumer digital-audio-tape products, as reapplied to computer-data storage, holds the promise of storing more than a gigabyte on a small cassette. At the same time, the makers of quarter-inch-cartridge (QIC) tape drives are developing products with 320-Mbyte storage capacities and have plans to boost this total to more than 1 Gbyte on the same size cartridge. Minicartridge tape drives, which use ¼-in. tape packaged inside a smaller cartridge, are now offering 40- and 80-Mbyte capacities and have plans to go to 110 Mbytes.

Of the various tape technologies under development, DAT has been given more than its share of attention because of the battle among rival groups to establish a standard. The group with growing momentum is the Digital Data Storage (DDS) team led by Sony Corp. and Hewlett-Packard Co., says Robert Abraham, vice president at Freeman Associates Inc., a Santa Barbara, Calif., market-research firm. The other player is called DATA/DAT, which is being led by Hitachi Ltd. with some help from Apple Computer Inc.

"DAT is not a high-performance product, but it does have two outstanding features," says Abraham. "One is that it has very high capacity, from 1 to 1.3 Gbytes. The second is that the medium is very low in cost and very small—about 20% smaller than a conventional audio cassette." Freeman Associates predicts that the DAT-drive market will grow from a few hundred units in 1988 to 71,000 units in 1990.

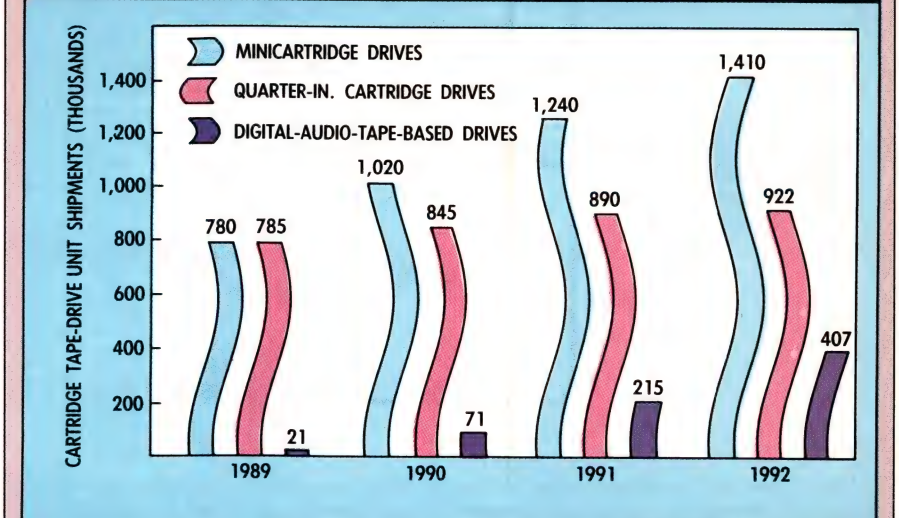
Whichever DAT format comes forward will have to displace QIC tape, says Robert Root, vice president of marketing and sales at Carlisle Memory Products Inc. in San Diego. This "will not be an easy task, considering that ¼-in. tape offers faster data-transfer rates and will have equivalent capacity within a year," he says.

"The DAT development and competition from optical [disk drives] had the effect of unifying ¼-in.-tape-drive manufacturers," says Root. As a result, this type of drive has seen intense development over the past few years.

FORMATS GALORE. The QIC committee, an ad hoc industry group that defines the recording format for both the standard and minicartridge ¼-in. tapes, has defined standards for 150, 320, and 1,500 Mbytes on the standard cartridge and up to 500 Mbytes for the minicartridges. In addition, by adding more tape inside the cartridge, the capacities can all be increased by 50%.

Freeman Associates is predicting that the sales of minicartridge drives will grow from 517,000 units last year to 1.54 million units in 1993. Sales of the standard QIC drives will grow from 743,000 units in 1988 to 940,000 units in 1983. The standard QIC units will be used in work stations and servers on local-area networks. Cartridges are also being used to distribute data and software from one system to another. *–J. McL.*

CARTRIDGE TAPES: NO CLEAR WINNER



SOURCE: FREEMAN ASSOCIATES INC.

$2,500. Even the attempts of the broadband vendors to bolster their competitive position by offering multiport modems falls short. Chipcom's eight-port modem, for example, costs about $5,000, Lawrence says. That brings the cost per connection down to $625—still $275 more than the baseband competition.

So with the vast majority of LAN connections remaining baseband, broadband's niche lies in tying them together and providing multiple-channel networking to customers who want it. Not surprisingly, these benefits are becoming increasingly complementary as corporations become more communications-oriented. If a customer is going to install a backbone to link LANs, the argument goes, why not one that carries video, voice, and data instead of just data?

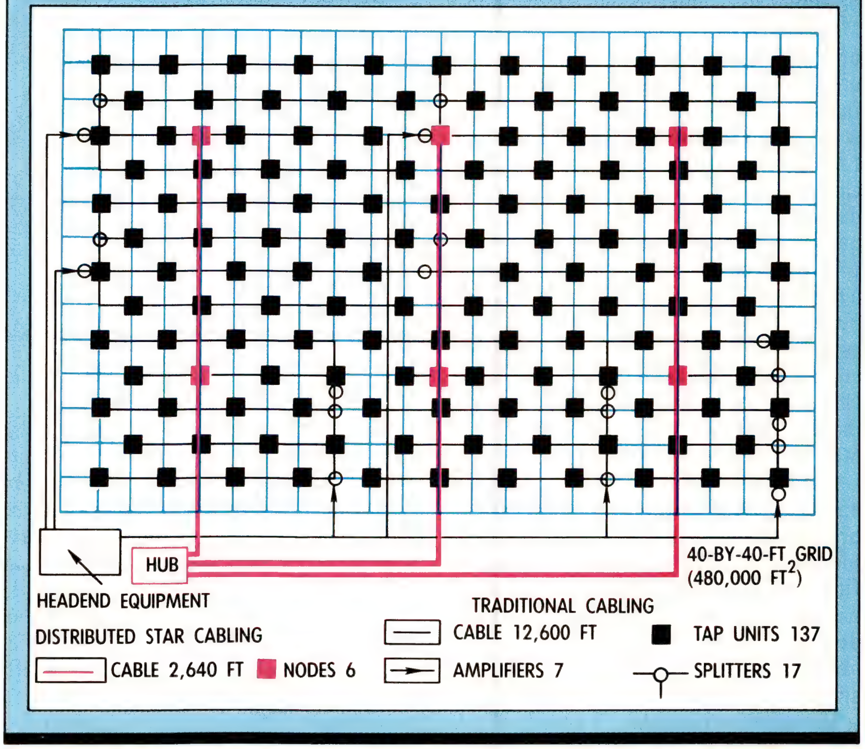
Until now, the answer might still have been "thanks, but no thanks." That's because broadband nets were expensive to install and needed an rf expert to maintain. But the new cabling system from Broadband Networks Inc. of State College, Pa., and AMP Corp. of Harrisburg, Pa., offers a remedy. The LAN-Line Broadband Star Wiring System can replace the custom-built broadband net with a less costly design that's close to being plug-and-play. "We put a lot of the system engineering into the hardware, so you don't have to know anything about rf to maintain it," says Steve Davidson, Broadband Networks' vice president of marketing.

Since the product solves most network-wide rf-engineering problems, engineering costs are greatly reduced—so much so that a complete wiring job costs 40% to 60% less than installing the alternative, a branching-tree network, he says. "You don't have to put up $1 million to totally cable a 2-million-square-foot building any more; you can start by spending as little as $10,000 and expand as the need arises."

EASY TO RUN. Once installed, the network is a breeze to run. For starters, it replaces the normal aluminum-shielded CATV cable with inexpensive RG-11 cabling. More important, it uses a distributed-star topology instead of the branching-tree topology of conventional broadband networks.

"With a CATV system, you had 16 adjustments to make periodically," Davidson says. "We need just one." With the old topology, customers had two unattractive options forced upon them by the fact that rf signal integrity is sensitive to overall network loading. They could design a small network knowing that a complete redesign would be required when it came time to expand. Or they could invest a big chunk of money to install a cabling grid that would allow for expansion but initially would be underutilized, probably for years.

A WAY TO SAVE ON CABLING COSTS



A new cabling system developed by Broadband Networks Inc. and AMP Corp. radically reduces CATV cabling costs and allows broadband networks to grow incrementally.

The distributed-star topology sidesteps these problems because each "service node"—the point from which user connections radiate—can be engineered to be electrically independent of the rest of the network, says Davidson. This means network designers can add new service nodes using only some additional cable, which has predictable losses, plus an equalizing, or line-balancing, module to compensate for those losses.

Unlike baseband nets, broadband carries data, voice, and video on one cable

Distributed by AMP, the system's distributed-star topology is set up so that each node in the star serves a specific, well-defined area. By contrast, most installations now are based on a nodeless linear signal path, as in the branching-tree scheme. Each service node, located in a wiring closet, can support up to 127 user connections over direct wiring. The service nodes connect directly to a hub, which can support up to 150 nodes. The system conforms to IEEE 802.7 standard specifications for a broadband coaxial-cable system, and it delivers all the services of a CATV wiring system, says Davidson.

Depending on the success of the LAN-Line Distributed Star Wiring System, market estimates for broadband networks could be thrown into a cocked hat. But other market forces and technologies—especially fiber optics—will also have an impact on the long-term growth rate. "Broadband is an effective and mature technology," says Daniels of DEC, "but our market research also indicates that customers are expressing a lot of interest in fiber-optic backbones." That technology will be hampered by a lack of networking standards, she says. On the other hand, "very often customers will set standards based on their own requirements." FDDI, for example, is on its way to becoming a de facto industry standard, and network vendors have widely adopted 62.5-μm fiber-optic cable as the cabling system of choice.

Lanex's Greaney estimates a higher overall 1990 broadband market than does Chipcom's Lawrence: it will hit $350 million, he predicts, a figure representing about 18% of a total LAN-equipment market of $2 billion. Broadband Ethernet should nab a 13% share of the $214 million LAN-bridge market by that time, he says.

Both Lawrence and Greaney believe the broadband market could be even larger if its benefits become better known. Besides its other attributes, broadband Ethernet matches baseband in giving users access to high-level protocols such as Transmission Control Protocol/Internet Protocol (TCP/IP), DECnet, IBM Corp.'s Netware, and OSI protocols.

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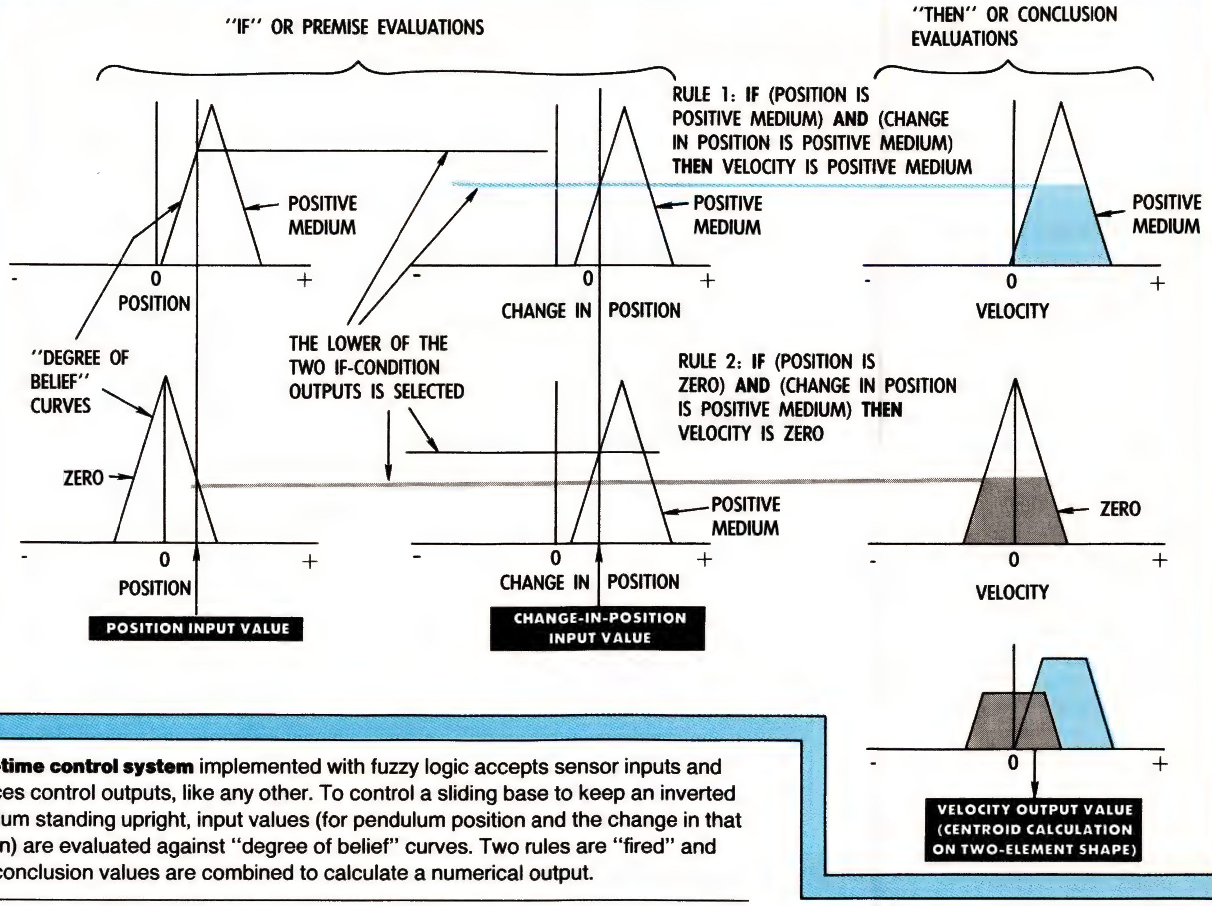
HOW FUZZY LOGIC DEALS WITH UNCERTAINTY


"IF" OR PREMISE EVALUATIONS
"THEN" OR CONCLUSION EVALUATIONS
RULE 1: IF (POSITION IS POSITIVE MEDIUM) AND (CHANGE IN POSITION IS POSITIVE MEDIUM) THEN VELOCITY IS POSITIVE MEDIUM
POSITIVE MEDIUM
POSITIVE MEDIUM
POSITIVE MEDIUM
- 0 +
POSITION
CHANGE IN POSITION
VELOCITY
"DEGREE OF BELIEF" CURVES
THE LOWER OF THE TWO IF-CONDITION OUTPUTS IS SELECTED
RULE 2: IF (POSITION IS ZERO) AND (CHANGE IN POSITION IS POSITIVE MEDIUM) THEN VELOCITY IS ZERO
ZERO
POSITIVE MEDIUM
ZERO
POSITION INPUT VALUE
CHANGE-IN-POSITION INPUT VALUE
VELOCITY OUTPUT VALUE (CENTROID CALCULATION ON TWO-ELEMENT SHAPE)

A real-time control system implemented with fuzzy logic accepts sensor inputs and produces control outputs, like any other. To control a sliding base to keep an inverted pendulum standing upright, input values (for pendulum position and the change in that position) are evaluated against "degree of belief" curves. Two rules are "fired" and fuzzy-conclusion values are combined to calculate a numerical output.

fore the chip," Togai says. But "we face a massive education task in teaching users an entirely new system." What makes it so different from conventional programming, of course, is that "there are no absolutes." The Togai compiler is the tool designed for developing expert systems that typically use a lot of imprecise information. Togai training material shows an experienced programmer how to describe in fuzzy-logic terms the "vague approximations embodied in [human] language," says Togai.

A BLACK ART. Handling the "membership functions" or "degree-of-belief curves," which are key descriptive elements that must be determined for any production rules in the knowledge base, for example, can be "somewhat of a black art," says Carl Perkins, vice president for business development at Togai. New terms must be learned, too, such as "defuzzification," which is a means offered by the compiler for generating a "crisp" data output—an actual numerical value—when needed. One way of defuzzifying is the centroid method, which produces the output by a center-of-gravity averaging technique. Another defuzzifies by picking an average of a centroid and other values.

The company has a training program on a floppy disk for personal computers. It illustrates fuzzy-logic principles through an example: controlling an inverted pendulum. The fuzzy controller uses sensor inputs for pendulum position and movement, evaluating those inputs with production rules to produce a control output for moving the base the pendulum stands on. By sliding the base back and forth, the controller balances the inverted pendulum, like a vertical rod balanced on the palm of a hand (see diagram).

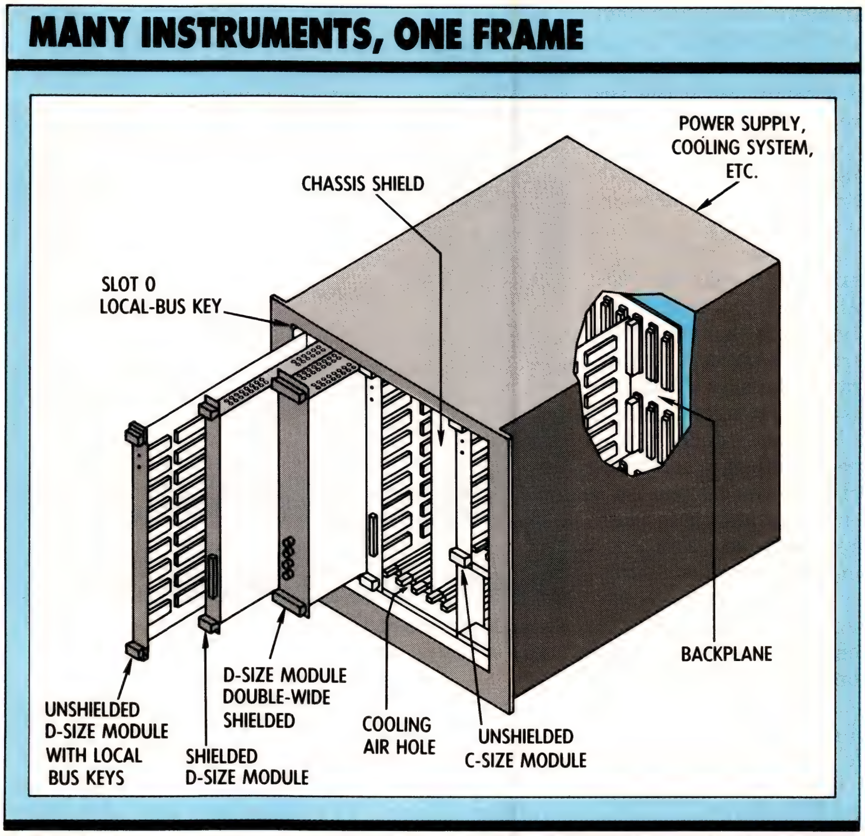
The input values are evaluated as points on degree-of-belief curves. The curves have been arranged to approximate the meaning of linguistic expressions like "the position of the pendulum is zero." The expression indicates that the pendulum is at the zero-position angle, corresponding to the straight up, or balanced, position. Another expression, "the position is positive medium," means the pendulum is slightly to one side of the upright position.

Different points on one curve indicate the degree of belief, or the probability level, that the position is zero: belief is at its maximum exactly at zero, but belief tapers off gradually, rather than abruptly, as values diverge from the zero point. Simple triangular curves are often sufficient, says Perkins, but smoothing them out into bell-shaped curves can sometimes improve system accuracy.

Potential users may balk at the notion that some odd shape representing combinations of a very few "belief values" about where the pendulum is and how much it has moved can be used to perform this tricky real-time balancing act. But when they've gone through the demonstration, two things stand out: it's easy to set up, and it works very well as a solution to a complex problem.

Togai estimates that 10% of expert-system implementations will incorporate fuzzy logic in the near future. Consumer and business equipment have the most potential. "As soon as a fuzzy processor is built into an appliance or office-automation device, competing manufacturers will be forced to follow suit to maintain market share," he says. Some U. S. companies have projects looking at fuzzy logic, though at a pace well behind Japan.

The bedrock advantage comes from simplicity and the fact that when working with classical logic, "precision is expensive." One reason the Japanese lead the fuzzy-logic pack is that "they have found they don't need high accuracy in many applications and there's a significant payoff [from fuzzy logic]," Zadeh says. ☐



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UNSHIELDED C-SIZE MODULE

Putting all instruments in a common mainframe, like this D-size model, and plugging them into a high-speed bus helps to overcome GPIB limitations.

Having 78 manufacturers out there building to the standard at this point in time is tremendous, considering the short time it's been out."

One reason is that competitive and technological pressures won't let instrument makers or users ignore VXI. "Anybody who has been involved with the GPIB in the past in any way, whether they're an instrument manufacturer or a GPIB user, is interested, because it will directly affect their applications," says Ron Wolfe, strategic marketing manager for National Instruments Corp. in Austin, Texas. "Today's marketplace is kind of like what you see when sharks get into a feeding frenzy. If you just get it started, it will fuel itself, because everybody's so scared of getting behind their competitors that they can't afford not to learn about it right away."

Galen W. Wampler, an industry analyst and president of Prime Data Corp. in San Jose, Calif., agrees with that prediction. He estimates that within 10 years, 20% of what will then be a $10 billion test-instrumentation market will be dedicated to VXI-compatible products. He says that 40% of this market will be what he terms "computer-dependent" by the year 2000, and half of that will belong to VXI. "It will be a strong growth factor for the instrument industry," he says, "particularly for high-performance instruments now in the $1,000-to-$3,000 range, and more complex measurement systems up to $20,000." Another observer—Malcom Levy, the marketing manager of Racal-Dana in Irvine, Calif.—reckons that VXI will constitute one third of the automatic test equipment market within five years.

MATE SUPPORT. A major factor in launching VXI was its adoption last July by the U. S. Air Force as the instrument-on-a-card standard for its Modular Automatic Test Equipment, or MATE, program. The Air Force got involved in 1985, when it asked the MATE User's Group for recommendations on standardizing instruments on cards. The request came as part of a general push by the military to cut the size and weight of test equipment and reduce the number of different kinds and sizes of boxes it was using. The Army and Navy formed similar programs, but eventually elected to go with their own, less commercially oriented, standards. The Air Force, though, wanted to use as much commercial equipment as possible, leading it to the VXIbus.

Early in 1987, technical discussions and exchanges among instrument manufacturers began, aimed at developing commercial and military modular-instrumentation standards based on the VMEbus. A proposal to establish an IEEE working group was submitted to the IEEE Standards Board, which approved the formation of the P1155 working group. The five-member consortium submitted version 1.1 of the VXIbus specification to the working group in October of 1987 and, after verification of interoperability of early products, followed it with version 1.2. Recently, IEEE P1155 adopted version 1.2 as a base document for consideration as an IEEE commercial standard. Official adoption is virtually assured. Thus, the VXIbus standard stands beside the GPIB standard as one of the watershed developments in shaping the future direction of test instrumentation.

Competitive pressure leaves users and vendors no room to ignore VXI

The VXIbus specifies three addressing techniques that can be used in an IEEE-488-to-VXIbus interface. These are designated IEEE 488 primary addressing, IEEE 488 secondary addressing, and embedded addressing protocols.

With primary addressing, each VXI instrument appears to the host controller as a separate IEEE 488 instrument with its own address, command, response, status code, and state storage. The interface must recognize each of the VXIbus devices through its IEEE 488 address and interact with each for reads, writes, serial polls, and so on. This results in a considerable overhead of lost time between transactions. The advantage is that software packages, tools, or drivers designed to work with IEEE 488 instruments will work with their VXI equivalents with only an address change required. One disadvantage is that there are only 31 primary addresses available, so conflict could arise in a multiframe system.

Secondary addressing is the method most commonly used, because it maps GPIB onto VXI in a straightforward manner. It is similar to primary addressing, but with it a single primary address designates the entire VXIbus system, using IEEE 488 secondary addresses to route 488 communications to or from VXIbus instruments in the mainframe. With this method, the 488 primary address locates the particular 488-VXI interface, then, via the secondary address, locates the specific VXI instrument within the system.

The third method, embedded addressing, can be used to link VXI systems to non-GPIB controllers. Here, a single unique address is assigned to the VXIbus system. A header is attached to each message identifying its destination device.

Which approach is best to use is a subject of some debate among the VXI consortium. Tektronix Inc. believes the embedded addressing system offers a number of advantages for what it calls the "superinstrument" concept the company favors. "What we're doing is using the idea of a single-primary, single-secondary address, so that the collection of VXI in-says Larry Desjardin, research and development section manager at HP's Loveland Instrument Division. "We announced our E1400A mainframe in August of last year, although we were shipping it earlier—in March—to some customers. That was before there were any instruments available. You wonder, if there are no instruments, why would they want cages? Well, we found that people were using them to develop their own custom modules for some unusual functionality they needed."

That kind of interest is still a little unusual, says Lou Klahn, marketing manager for Colorado Data Systems Inc., Inglewood, Colo., a company that helped pioneer the instrument-on-a-card concept. "There's been a big rush toward developing product and a lot of interest on the part of the customer," Klahn says. "I don't think that a lot of customers have put forth their hard-earned dollars yet, but I think that's primarily a budget-cycle problem as opposed to anything to do with the technology or the standard itself."

One possible reason for the deliberate pace with which products are being introduced is the fact that some sophistication is required of both designers and users of VXIbus instrument systems. Designers already familiar with VMEbus standards will not have a lot of difficulty with the VXI extensions. However, those who were used to putting rack-and-stack systems together via IEEE 488 will miss the knobs and displays that enabled them to set up and adjust the equipment.

VIRTUAL KNOBS. But more products are starting to appear. In fact, the lack of knobs and displays is itself giving rise to a whole class of products: software tools that produce virtual instrument displays on a PC screen. They include National Instruments' LabWindows, an MS-DOS-based tool that permits program creation and operation through a library of instrument control functions. LabView, a similar package for the Macintosh, is also available from National. Wavetek's Wavetest and HP's newly introduced Interactive Test Generator are equivalent tools. Although designed initially for the PC-based instrument-on-a-card market, they can easily be adapted to VXI through a GPIB interface such as National Instruments' GPIB-VXI or Colorado Data Systems' 73A-151. In fact, at the ATE West show in January, National showed a version of LabWindows designed to work directly with VXI systems, although it is not yet a product.

VXI-system-development tools and mainframes are also becoming available from several companies, among them Colorado Data Systems, Hewlett-Packard, and Tektronix. For those ATE system designers who want an optimum match between the high performance of the VXIbus and the breadth of software afforded by direct PC control, Radix Microsystems' EPC-2, and the 73A-160 VXIbus-compatible personal computers will be welcome. They are 80386 and 80286-based PC ATs, respectively, which are designed to plug into VXI C-sized mainframes. They not only provide IEEE 488 interfaces, but can also act as complete VXI resource managers. "If you have a PC embedded in a VXI environment, you end up with a very high-performance system, because you're not using the slow GPIB interface to communicate and transfer data back and forth," says Glen Myers, president of the Beaverton, Ore., company. "Also, the PC world has a tremendous amount of software available that will be useful in a VXI environment. To us it makes sense to put the PC in the mainframe and have the PC have direct access to the instrument at the full bandwidth of the bus, to be able to drive the TTL and ECL trigger lines from the VXI backplanes directly." Tektronix, which owns 40% of Radix, showed its own D-sized version of the EPC-2, designated the 5530, at ATE West.

Using VXIbus demands sophistication, but software is making it easier

National introduced one popular interface product early in the game. Its GPIB-VXI board performs transparent conversion of IEEE 488 signals and protocols so that an IEEE 488 controller can control VXIbus instruments alongside IEEE 488 instruments.

Even after VXI-compatible products start appearing in larger numbers, nobody expects that VXI is going to replace GPIB any time soon. Neither will the VXI products eliminate monolithic bench instruments. "IEEE 488 go away? I don't think so," says Radix Microsystems' Myers. "I think there will be a short-term tendency for anyone who has an idea for the world's best next instrument to do it both for 488 and VXI, and then there'll be some point when people won't consider 488 any more."

Others, like Colorado Data Systems' Klahn, point out that some types of instruments—spectrum analyzers, for example—do not lend themselves to modularity. And Bo Ray, vice president of marketing for Rapid Systems Inc., a manufacturer of instruments on cards for PCs, says, "VXI is a great standard, and will be very important. But a majority of instrumentation situations call for a single instrument. The cost of PCs is coming down and the power is going up, and a lot of software is available. So we see a continuing market for PC-instrument cards in a cost-conscious environment."

Not everyone is so sanguine about the future of monolithic benchtop instruments or non-VXI PC-based instruments. "I think in the long term, the days of the instrument panel with control buttons and little displays are over," says Richard Faubert, vice president of product development at GenRad Inc. in Concord, Mass. "VXI with instruments on a card and some kind of PC with windows is the way to go." GenRad sees VXI as a useful adjunct to the automated test equipment business, but without a major impact on ATE itself.

"We have a development effort to get ourselves ready to be able to provide custom options—it isn't that we will have a fixed set of instrumentation available," Faubert says. "It will be used by the custom-products operation where that group can add instrumentation, particularly analog, at customers' requests. We're trying to get up to speed to be able to select and integrate VXI boxes into the mainline system." ☐

THE AIR FORCE AND NASA MOVE ON VXI

Air Force support is a big factor in the development of VXIbus. One of the first major military contracts based on the standard is a deal worth $72 million for the Corsair Avionics System Tester. CAST is automatic test gear for testing the bombing and navigation systems of the A-7 aircraft. Allied Signal Test Systems' Teterboro, N. J., division expects to complete a prototype in May and deliver production units next January.

"VXI allows us to use standard, available, off-the-shelf instruments," says Lawrence Gioielli, engineering manager for the A-7 at Allied Signal. "So the real saving isn't just up front—it's in the life-cycle costs. If you had a group of unique instruments, the Air Force would have a hard time supporting the system in the future. With VXI, you can add devices when you want. If I design my own bus, it's a whole new system for the Air Force to learn and support."

Another major use of VXI will be in a Hewlett-Packard Co. automatic test system for Rockwell International as part of the space-shuttle program. The system is actually being designed and built by Tasco Electronic Services Inc. of Anaheim, Calif. It will include several commercial modules, says Carmy Yellin, a Tasco senior system engineer. But its core is a Tasco-designed programmable serial word generator, recorder, and analyzer built to VXI standards. Tasco plans to offer the unit as a product. *–S. W.*

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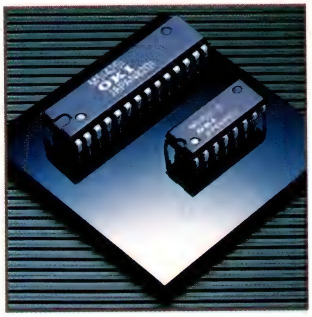

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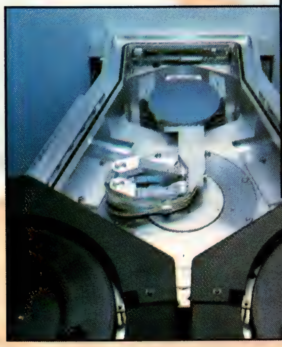

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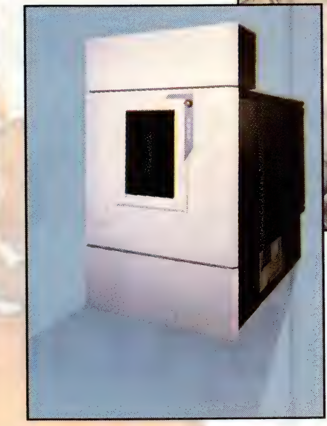

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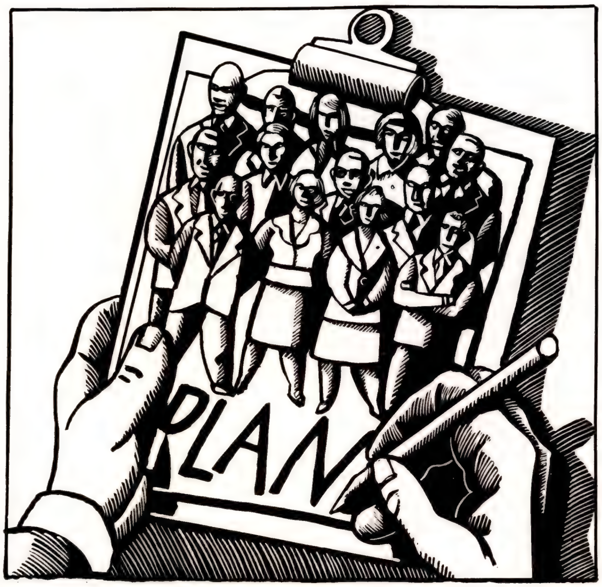
A FIVE-YEAR PLAN THAT REALLY WORKS

At Analog Devices, detailed agendas spark growth

Five-year plans are helpful corporate strategic-planning tools, but it's doubtful that many of them are as detailed, involve as many people, or are as public as those that guide Analog Devices Inc. They force Analog to analyze what kind of company it is and should be, and they also force a consensus commitment among senior managers. The current version, covering 1988-1992, is the fourth. It embodies ideas from 150 people on 16 committees and task forces and was almost two years in the making.

Something else about the plans: they seem to help stimulate growth at Analog. Since the company wrote the first one in 1972, revenue growth has averaged about 25% a year—from $15.6 million that year to $439 million for fiscal 1989, which ended last Oct. 31.



Not all the plans have met all the goals of the Norwood, Mass., manufacturer of analog and digital signal-processing products—primarily integrated circuits. The most painful and glaring failure was the anemic growth performance of the company in 1985 and 1986, says Ray Stata, chairman and president.

With the plan calling for revenue growth of 27% and 12% in those years, the actual increases were just 3% and 4%. Stata attributes the low growth to "an unusually violent boom-bust cycle of semiconductor production and inventory accumulation."

As the driving force behind the five-year-plan concept, Stata says that he has been pivotal in formulating and executing the schemes. However, his input has diminished over time as he has deliberately involved more senior planners. "But the CEO has an important role in setting expectations for the planning process," Stata says. "Equally important, when the plan is finished, the CEO has a unique responsibility to communicate the plan," both inside and outside the company.

There are 11 major objectives in the current program. A key one is revenue growth of 20% per year and return on capital of 15%, both figures outpacing the industry average. Achieving the revenue-growth goal would make Analog Devices a $900 million corporation in 1992.

Some of the plan's other objectives aren't as easily measured but are no less important, Stata says. Those include meeting employee expectations for employment security and personal growth; achieving excellence in low-cost, high-volume manufacturing; and achieving continuous organizational learning and improvement.

The foundation for the plan was laid almost two years before it was finished, with formation of a strategic planning committee. The early meetings were essentially brainstorming sessions among top management to determine corporate objectives "and identify the significant things we had to change as a company—the imperatives for change," Stata says.

The strategic planning committee spun off task forces, which were charged with addressing, among other issues, human resources, quality improvement, and diversification. The task forces in their turn have evolved into several standing bodies, including groups on business planning, human resources, and information systems, plus a quality-improvement steering committee. They meet at least once a quarter to monitor progress.

by Lawrence Curran

The "imperatives for change" that grew out of the current plan included recognition that the company needs to penetrate new markets without losing its leadership in those it dominates; become both a product innovator and low-cost producer; and improve in customer performance ratings.

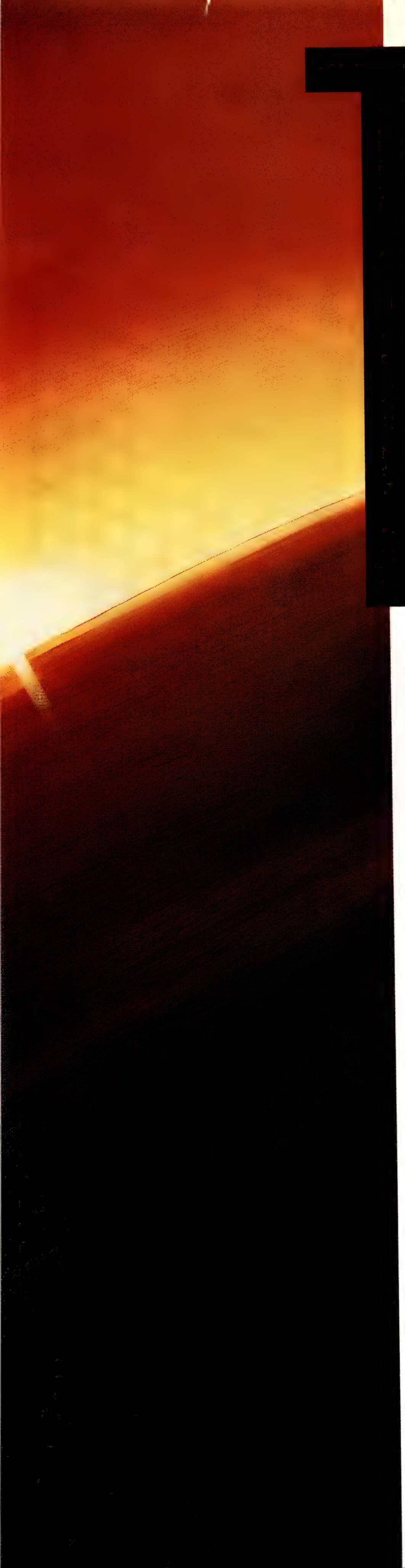
Becoming a low-cost manufacturer involves a fundamental change and directly affects the firm's ability to crack new markets, company executives say. Historically, Analog's proprietary-products business has involved high-performance, relatively high-priced linear and mixed-signal ICs produced in much lower volumes than are digital circuits like dynamic random-access memories. Consequently, the firm had assigned relatively low priority to economical high-volume manufacturing.

But that's changing as the company moves to provide components that are used in consumer audio and video equipment as well as in disk drives, all of which must be produced in high volume at competitive prices.

Another of the plan's objectives resulted in the formation of a quality-improvement program. That goal grew out of the company's recognition that although Analog Devices may be the market-share leader in a number of product categories, "we didn't stand out in the minds of our customers as leaders in quality and service," Stata says.

The quality push was actually launched before the current plan was written. But Analog has seen fit to make quality improvement one of the plan's 11 objectives: to achieve leadership in vendor ratings as measured by on-time delivery, low rejection rates, and overall responsiveness to customers' wishes.

Finally, while some may wonder how the five-year plans affect Analog's competitive position, Stata points out that the amount of market, technology, and product analysis that goes into the plans can't help but make the company a stronger competitor. He reasons that if the plans are sound "and we meet our objectives, we'll be addressing the competitive issues as well." ☐



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COMPANIES TO WATCH

THE QUIET MONEY MAKER SPINS OFF STARTUPS ITS OWN WAY

Burr-Brown's inside ventures get into the black in a hurry

TUCSON, ARIZ.

Burr-Brown Corp. always did march to a different drummer. In part that's because the components maker has been doing business since 1956 far out of the geographic mainstream, down the road from Phoenix and nearly 1,000 miles away from Silicon Valley, and partly because the firm's products aim at uncrowded niches. One result of the path blazing is near-anonymity: despite an enviable record, Burr-Brown is one of the least-known chip-based firms.

The company has parlayed its specialty in linear-conversion devices and the data-acquisition equipment that uses them into sparkling annualized growth rates. For much of the decade they've exceeded 20%. Burr-Brown even sailed relatively unscathed through the downdraft that drove most chip firms deeply into the red in 1984-85. And now with its basic stand established, it is adding a new arrow to its quiver. As is typical with the firm, it is taking a basic tactic—spin-offs—and giving it a twist.

Not that the company appears to need anything new. Net income in 1988 was $11.5 million on nearly $177 million in revenue, both records. "They've built a good, solid company," says Raj Rajaratnam, financial analyst at New York's Needham & Co. He says, and other analysts who track the firm agree, that "Burr-Brown usually does things its own way."

Rajaratnam is most impressed with Burr-Brown's success in international markets. He points to Japan, where it has more than a third of its sales. "It's done the best job there of any U. S. chip company," he says. Pacing the company's Japanese action is a digital-to-analog chip for compact-disk players, accounting on its own for some $25 million or 75% of its market. In the wings, awaiting the predicted takeoff of digital audio tape, is an analog-to-digital unit, the PCM78, that could be as successful as its CD mate.

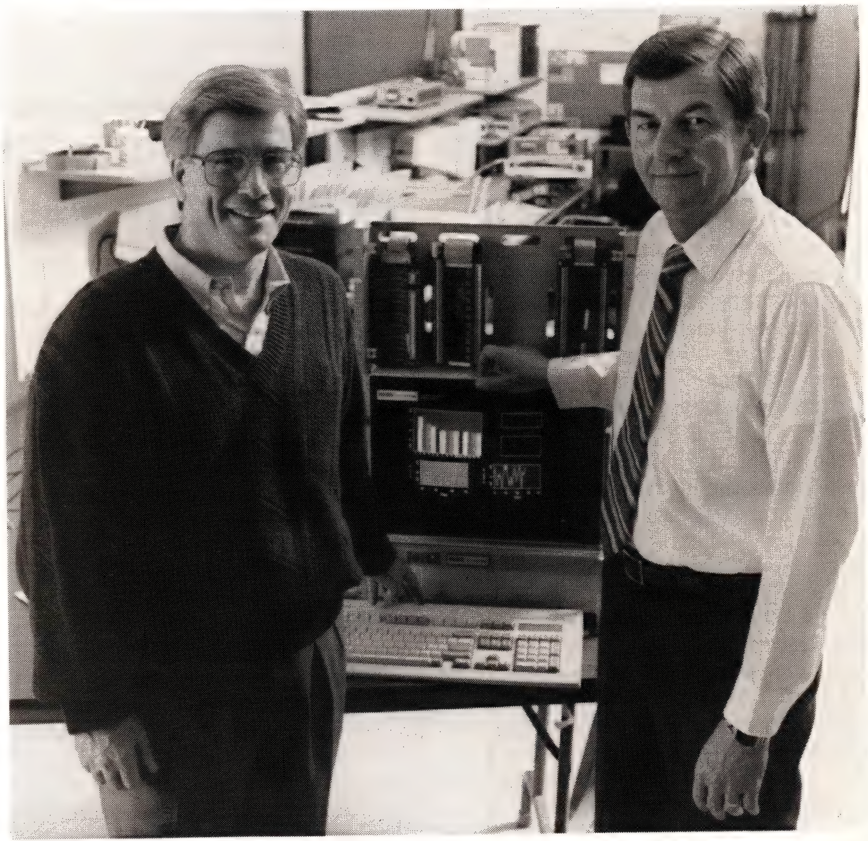
Moreover, the company's customer roster of the largest Japanese consumer-electronics houses makes it even more unusual among U. S. chip-based firms. Since it started selling in Japan in 1975, it has gone about its work quietly, with no complaints about Japanese trade barriers or nationalistic buying practices. It has done nothing unusual—it divines customer needs early, works closely with them, and delivers quality products on time—but it has done them well. A major reason, says president and chief executive officer James J. Burns, is that "it's always a Japanese national [from Burr-Brown] sitting across from those Japanese customers."

Not content to rest on those laurels, Burr-Brown is turning to another approach to spur growth from new businesses. Using so-called intrapreneurship, it involves helping employees with new ideas to spin off companies that will exploit them. The point is to keep those employees from leaving to do their own thing. If they stay, the parent company can share the fruits of their ingenuity.

The technique has been tried elsewhere with varying degrees of success; characteristically, Burr-Brown is doing it with a twist. It launched successful spin-offs—in personal-computer expansion boards, specialty power supplies, and modems and multiplexers—between 1983 and 1986. Now a fourth, in communication networks, is being prepared for launching.

One difference from other companies' inside spin-offs, which usually take a while to show profits, is that all three of Burr-Brown's went into the black about 18 months after startup. Although their total sales volume is still only about $11 million, the signs are pointing to a rapid climb, says Burns.

The main problem with intrapreneurial



Checking the latest product of Intelligent Instrumentation Inc., a Burr-Brown venture, are Jim Burns, left, president of Burr-Brown, and Gene Tobey, president of the new venture.

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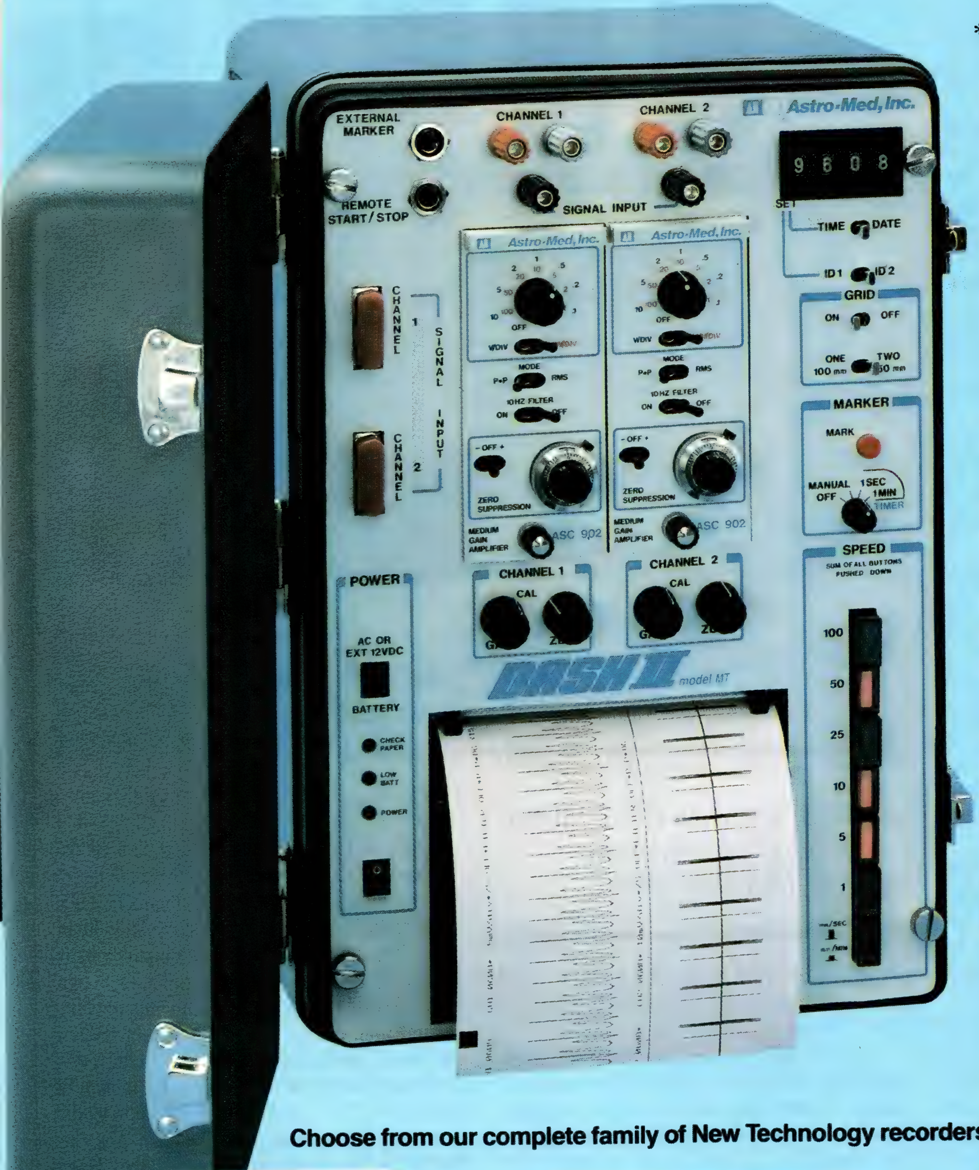

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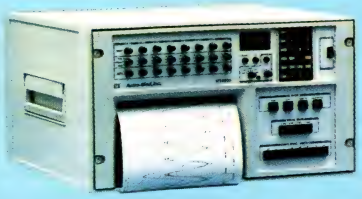

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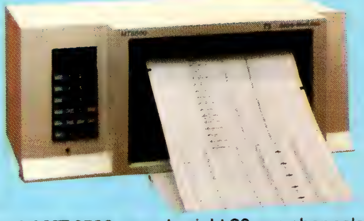

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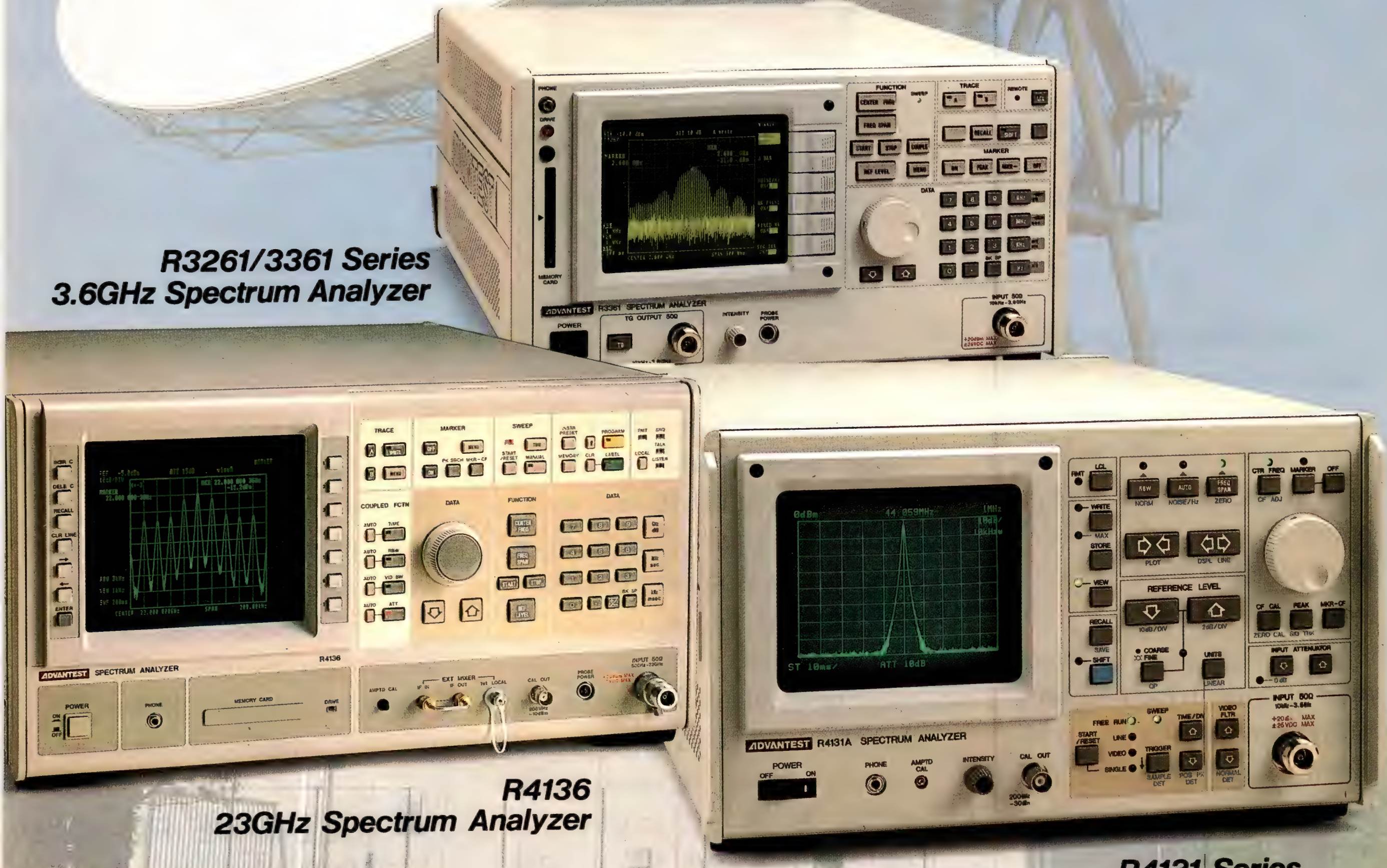

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PEOPLE TO WATCH

HOW MIKE BENNETT PLANS TO GUIDE INTERLAN'S SKYROCKETING GROWTH

He wants to leverage the company's in-house talent to expand into software

BOXBOROUGH, MASS.

When Michael Bennett joined Interlan Inc. early last year as vice president for operations, he felt as if he were hitching a ride on a rocket. That's understandable: the company's fortunes were zooming. Revenue had grown at more than 40% annually for several years.

The rocket is still climbing, but now Bennett, the new president and chief executive officer, is steering and he's intent on breaking through the $50 million barrier and soaring on to $100 million in annual revenue.

Bennett, 37, was recruited by his predecessor and friend, Michael Barker. It had been Barker's intention for some time to leave the company after turning the business around. That done, he brought Bennett aboard in January 1988. The plan from the start was for Bennett to take over at Interlan, a supplier of local-area-network products that integrate computer systems shared by departmental work groups.

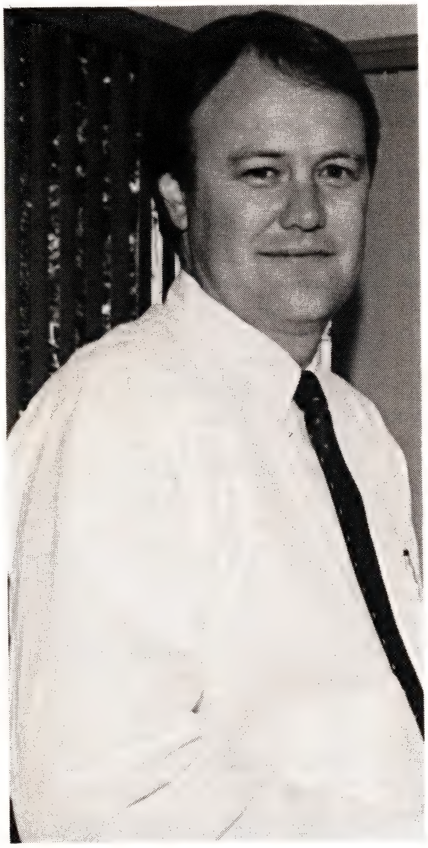
Barker's task was the result of a slowdown that afflicted Interlan a few years after the company was founded, in 1981. At first Interlan had taken off fast, but within four years growth had slowed seriously enough for the company to start casting about for a corporate parent. It found one in Micom Systems Inc., a Simi Valley, Calif., provider of local-area- and wide-area-network products. Micom acquired Interlan early in 1985.

PRIVATE AGAIN. But Bennett says the marriage was never a happy one, largely because it stifled the entrepreneurial spirit that had pervaded the original, independent Interlan. Part of his current aim is to nourish that spirit, which was revived when Interlan was bought last September by Odyssey Partners, a New York-based investment firm that returned it to its privately held status.

Before coming to Interlan, Bennett, a fourth-generation Texan with traces of his native accent still peppering his speech, was a general manager at Tandy Corp. in Fort Worth, Texas. In addition, he has 12 years of general- and manufacturing-management experience at Digital Equipment Corp., acquired in various DEC facilities in New England, Phoenix, Scotland, and West Germany.

For some of those years Barker and Bennett worked together at DEC. They discovered their skills and temperaments were different but complementary. "Mike is a fantastic guy," Bennett says. "But he's a one-man show, and his view at Interlan was short-term. He's a turnaround guy and he had a short-term contract. His focus here was on what deal we can do this week with what original-equipment manufacturer. That's what the company needed."

Now that Interlan is back on its feet, the company needs someone who, in contrast to Barker, takes a long-term view. That's Bennett's forte. "My style is to create a company people feel they can grow with," he says. "I want to pay attention to the company environment and make it a good place to work. I'm not a one-man show."



Bennett: 'My style is to create a company people feel they can grow with.'

He says his approach encourages people to rise into the ranks of management, "because they can regard Interlan as their company, not Mike Barker's company. I want to make Interlan more than a quick stop in a career progression."

LINING UP. To assist in that aim, Bennett recently organized Interlan's widely varied products—there are 500 to 600 of them—into three lines: hardware-platform, network-management, and software products, each of which is headed by a product-line director. The three directors have gross-margin goals to meet, plus responsibility for deploying engineering resources to meet product timetables and developing the following year's financial plan.

On the financial front, Interlan had $32 million in revenue when it went private in fiscal 1988. The company will complete its fiscal year 1989 on March 31 at about $55 million, well above the revenue goal of $44 million. Bennett expects growth rates of between 30% and 35% in the next two or three years, which would easily bring the company through the $100 million plateau in 1992.

During that period, Bennett would like to see Interlan's image evolve. Currently, it's best known as a provider of low-end networking-hardware boards. He thinks it can build on that. "We have some exceptional talent on the software side of the house," he says, "and we're beginning to develop a more specific approach to leveraging software sales."

Toward that end, Interlan recently introduced a software product that provides a link between Novell Inc.'s NetWare LAN and a personal-computer-based file server running OS/2 LAN Manager software from Microsoft Corp. It's called Interlan LAN Server and it enables transparent interoperability between a NetWare client and the LAN Manager server.

"This is software only," Bennett says, "and we'll absolutely continue to develop this kind of product." *–Lawrence Curran*

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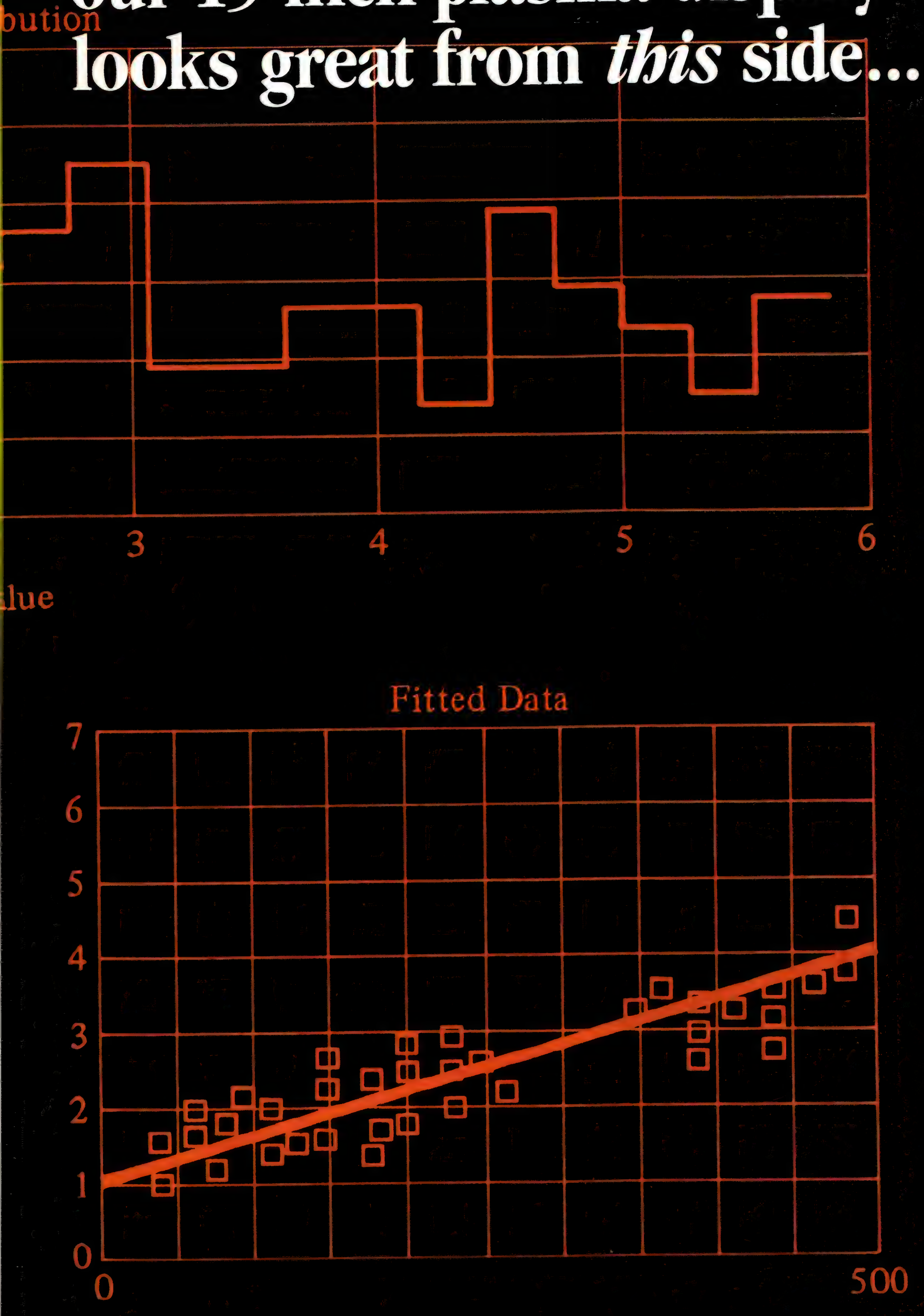

1/2 screen, shown ACTUAL SIZE

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BOOK REVIEW

TRACKING JAPAN'S ELECTRONICS INDUSTRY

THE STRUCTURE OF THE JAPANESE ELECTRONICS INDUSTRY
By Dodwell & Co. Ltd.
Tokyo: Dodwell & Co. Ltd. 70,000 yen; $540

The increasing value of the yen and the lack of growth in the formerly dominant consumer electronics sectors is forcing changes in the Japanese electronics industry. Japanese manufacturers are pushing their low-value-added products offshore and concentrating on making higher-value-added products at home. Imported products ranging from low-end consumer gear from newly emerging countries to minicomputers and work stations from the U. S. have become more competitive in Japan.

Meanwhile, other Japanese industries—those that are in worse straits because they don't benefit from the constant stream of new products that keeps the electronics industry vibrant—are pushing their way into the business. Steel manufacturers are now in the semiconductor business, and chemical and detergent firms are making optical and magnetic disks.

This book, by the Dodwell & Co. market-research group, attempts to track and analyze such changes through late 1988. It also presents a statistical snapshot of the industry at that time, along with tables charting its growth from 1983 or 1984 to 1987.

The book starts off with an overview of the industry and a description of the effect during the past few years of the appreciation of the yen. Short sections survey the communications sector, including new domestic and overseas common carriers and value-added networks; foreign companies' activities in Japan; Japanese steel manufacturers entering the electronics industry; capital investment; and research-and-development investment. Then comes a 40-page analysis of Japanese products with production value exceeding 100 billion yen; products with very high growth rates; and new products expected to become significant.

A large part of the book consists of profiles of Japan's nine electronics firms worth a trillion yen; the 36 worth 100 billion yen; and 330 smaller firms, in decreasing amount of detail. For the largest companies there is a great amount of data, including news of recent activities, lists of subsidiaries, affiliates, foreign associates, and research labs with products involved. (IBM Japan Ltd. just made it over the trillion-yen line in fiscal 1987, but it's relegated to the second tier in this book and so gets shorter shrift than the nine Japanese giants.) Tables compare the nine behemoths with each other and with 13 foreign companies.

In one sense, of course, much of the information in this book was out of date before it was published. But it does capture the state of the industry at a certain point, as its title promises. And it should be a useful starting place for anyone who needs to know about Japanese electronics, because it indicates what kind of information is readily available and the sources for it. Some parts, such as the convenient English list of industry associations, should change very slowly.

Although the book is published by an English trading firm, the language appears to have been written in a Japanese-dialect version of American English. Key words seem to be used in their dictionary form rather than according to the meaning dictated by the structure of the sentence in which they are used. Even more disturbing are mechanical translations, like the one that turned "central processing unit" into "main equipment unit." Most of the text flows smoothly, though, and a reasonably intelligent reader should not be inconvenienced.

A strong yen and sagging consumer business are forcing some changes

Also somewhat disturbing is the unquestioning acceptance of product categories used by the Ministry of International Trade and Industry and the Electronics Association of Japan. As a result, all those products that are not strictly consumer goods or components are considered to be industrial.

The index gives single-page rather than multiple-page references. Firms are listed under their English names; the Japanese name is included in parentheses if it's significantly different. Cross-referencing is provided for some but not all names—anyone who knows only the Japanese name of a company could get lost looking for it. There's no subject index, so a reader who wants to find particular topics has to look through the table of contents. *–Charles L. Cohen*

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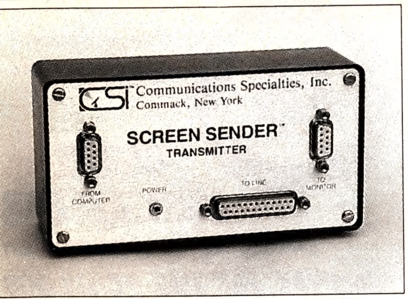

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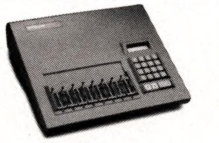

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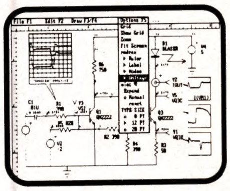

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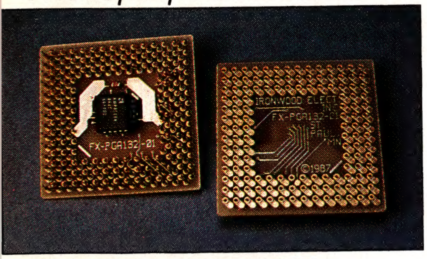

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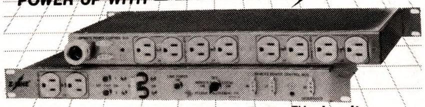

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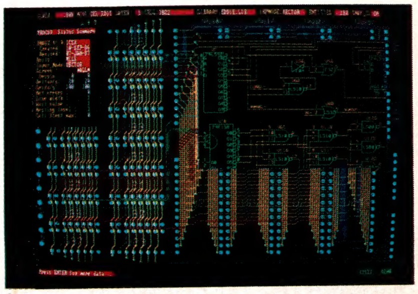

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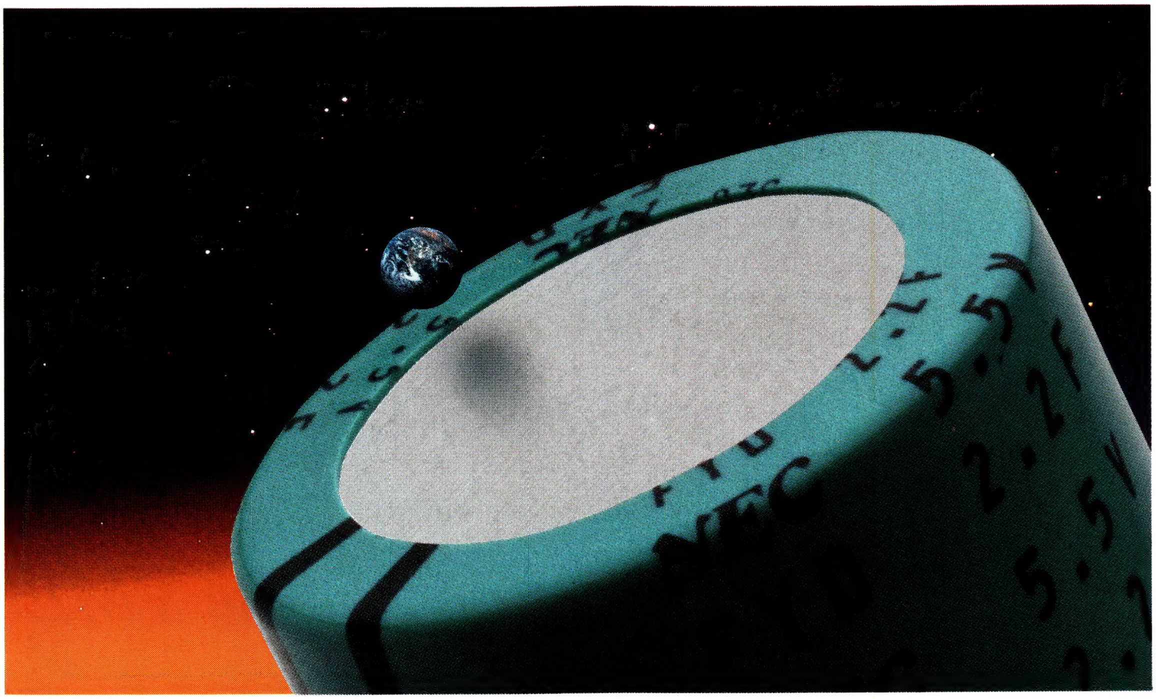

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